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Alaska Department of Fish and Game
Division of Commercial Fisheries
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October 1988

Bristol Bay Sockeye Salmon Smolt Studies for 1986

by

**Brian G. Bue, Donald L. Bill, Wesley A. Bucher,
Stephen M. Fried, Henry J. Yuen, and R. Eric Minard**

State of Alaska

Steve Cowper, Governor

The Technical Fishery Report Series was established in 1987, replacing the Technical Data Report Series. The scope of this new series has been broadened to include reports that may contain data analysis, although data oriented reports lacking substantial analysis will continue to be included. The new series maintains an emphasis on timely reporting of recently gathered information, and this may sometimes require use of data subject to minor future adjustments. Reports published in this series are generally interim, annual, or iterative rather than final reports summarizing a completed study or project. They are technically oriented and intended for use primarily by fishery professionals and technically oriented fishing industry representatives. Publications in this series have received several editorial reviews and at least one *blind* peer review refereed by the division's editor and have been determined to be consistent with the division's publication policies and standards.

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ABSTRACT

Sockeye salmon (*Oncorhynchus nerka*) smolt studies were conducted on the Kvichak, Naknek, Egegik, Ugashik, Wood, and Nuyakuk River systems within Bristol Bay, Alaska, during 1986. Estimates of numbers of smolt migrating to sea based upon data obtained from sonar equipment, were 136,733,218 from Kvichak; 41,329,355 from Naknek; 44,197,865 from Egegik; 53,076,253 from Ugashik; 28,064,408 from Wood; and 11,236,164 from Nuyakuk. Fyke net samples indicated that age-I smolt, from the 1984 brood year spawning escapements, were the dominant age class in five out of the six river systems (percent age-I smolt: 61.1% Kvichak; 53.6% Naknek; 71.4% Ugashik; 97.9% Wood; and 98.5% Nuyakuk). Age-II smolt, from the 1983 escapements, were the dominant age class in the Egegik system (68.1%).

KEY WORDS: juvenile sockeye salmon, *Oncorhynchus nerka*, juvenile migration, sonar, Bristol Bay, Kvichak River, Naknek River, Egegik River, Ugashik River, Wood River, Nuyakuk River

INTRODUCTION

Programs to sample and enumerate seaward migrating sockeye salmon smolt (*Oncorhynchus nerka*) provide data which are used to forecast adult returns and estimate optimal spawning escapement levels. Smolt sampling programs have been conducted on several of the rivers of Bristol Bay since the early 1950's. Initial studies used fyke nets to estimate smolt numbers [Kvichak River (1956-1974), Naknek River (1956-1977), Ugashik River (1955-1965, 1967-1970, and 1972-1975), and Wood River (1951-1966)] (Kerns 1961; Rietze and Spangler 1958; Jaenicke 1968; Pella and Jaenicke 1978; Burgner 1962; Burgner and Koo 1954). Although these programs furnished information on smolt age, size, and relative abundance, the data did not provide accurate estimates of smolt numbers. The feasibility of counting smolt using hydroacoustics was first examined in 1969, on the Kvichak River, by the Alaska Department of Fish and Game (ADF&G) through a contract with the Bendix Corporation (McCurdy and Paulus 1972; Paulus and Parker 1974). The first experimental smolt counter underwent several modifications over the years until two different models were built for use on the Wood (Krasnowski 1976) and Kvichak Rivers (Randall 1977) in 1975 and 1976, respectively. These programs were successful and have served as templates for further smolt enumeration studies on other Bristol Bay systems.

Smolt sonar was also tested on the Ugashik River from 1973-1975 using an early Kvichak experimental counter (Schroeder 1974b and 1975; and Sanders 1976) but was discontinued due to budgetary constraints. Consequently, smolt studies on the Naknek, Egegik, Ugashik, and Nuyakuk Rivers were limited to occasional fyke net sampling for age and size data from 1975 to 1982 (Huttunen 1980; Eggers 1984; Minard 1984). An experimental, two-array Kvichak system was tested on the Egegik River during the spring of 1981 (Bue 1982).

Smolt counters with additional modifications were purchased and deployed on the Naknek and Egegik Rivers in 1982 (Huttunen 1984; Bue 1984), and the Ugashik and Nuyakuk Rivers in 1983 (Fried, Yuen, and Bue 1987; Minard and Frederickson 1987).

Objectives of the 1986 Bristol Bay sockeye salmon smolt studies were: 1) to estimate the number of seaward migrating sockeye salmon smolt, 2) to describe smolt migration patterns, 3) to collect age, weight, and length data for smolts, and 4) to record climatological and hydrological parameters which may affect migratory behavior.

MATERIALS AND METHODS

Project Locations

The Kvichak River sonar site was located approximately 5 km (3 miles) below the outlet of Lake Iliamna. Three transducer arrays, the inshore, center, and offshore, were anchored at 22.9, 43.9, and 62.2 m (75, 144, 204 ft), respectively, from the east bank. The Naknek River site was located 13 km (7.8 miles) below the outlet of Naknek Lake. The inshore, center, and

offshore arrays were anchored at 14, 28, and 51 m (46, 92, and 167 ft), respectively, from the east bank of the river. A three-array system was also used at the Egegik River site located 4 km (2.4 miles) below the outlet of Becharof Lake. Inshore, center, and offshore arrays were located 40, 55, and 67 m (130, 180, and 220 ft), respectively, from the south bank. Two arrays were used in the Ugashik River approximately 50 m (164 ft) from the outlet of Lower Ugashik Lake. The inshore and offshore arrays were placed at 16.5 and 24.5 m (54 and 80 ft) from the north bank. The Wood River site was located at the outlet of Lake Aleknagik. Four arrays (I, II, III, and IV) were located at 21, 30, 42, and 54 m (69, 99, 137, and 177 ft), respectively, from the north bank of the river. A three-array system was also used on the Nuyakuk River, located approximately 3.5 km (2.2 mi) from the outlet of Tikchik Lake. Inshore, center, and offshore arrays were placed 27, 41, and 68 m (88.6, 134.5, and 223.1 ft) from the south bank, respectively.

Hydroacoustic Equipment

All hydroacoustic systems used to estimate smolt numbers were built by the Bendix Corporation. Each system was comprised of 3.03 m (10 ft) long transducer arrays, set on the river bottom, which were connected by coaxial cable to a control unit housed on shore in a canvas wall tent. All transducer arrays used on the Naknek, Egegik, Ugashik, Wood, and Nuyakuk Rivers housed 10 upward-facing transducers. The arrays used on the Kvichak River held seven upward-facing transducers and seven downstream-facing transducers. All arrays were retrieved at the end of the season, but attempts were made to place the arrays in the same locations each year.

Each system was factory calibrated to record one count for a specified amount of fish biomass (Kvichak River, 83.0 g; all other projects 41.5 g) passing through each transducer beam during a given time period. The system was designed so the arrays could be ranged independently of each other. This allowed the operator to set the counting range as near the surface as possible. A disable switch on each control unit allowed the person monitoring the equipment to manually stop tabulation of known false counts (i.e., counts due to floating debris, ice, entrained air from high winds or rain, etc.). The duration of disable time was automatically recorded and stored by the control unit. Manual settings on the control unit allowed the operator to adjust printing times for accumulated counts (7.5, 15, 30, or 60 minute intervals), transducer pulse rate, and the portion of the water column monitored. The unit also had ports for connecting an oscilloscope so that transducer signals could be visually observed. All smolt counters, with the exception of the Wood River counter, were designed to monitor three arrays of transducers. The Wood River unit was designed to handle two arrays. An additional switching box was added to the Wood River system to allow for manual multiplexing of four arrays.

Estimating smolt numbers

Estimation of smolt numbers was divided into three major steps: (1) hydroacoustic estimation of total fish biomass migrating down stream past the study site, (2) sampling of the fish population to estimate parameters such as species composition, age proportions, weight, and length; and (3) apportionment of fish biomass into numbers of smolt by age and species based on the estimated fish population parameters.

Biomass estimate

Hydroacoustic equipment at all sonar sites were monitored continuously. Each array was ranged as near the rivers surface as possible (usually within 1-2 cm (.4-.8 inches)) in order to detect all smolt in the water column. The river was continuously monitored for sources of false counts such as boats, wind, rain, debris, etc. and the sonar unit was disabled whenever false counts or false count conditions were detected. Known false counts were subtracted from the hourly totals and linear interpolation was used to estimate counts missed while the sonar was disabled.

Since smolt were assumed to migrate passively with the river current, signal pulse rate of the smolt counter was set to correspond with the river velocity measured over one of the arrays (referred to as the index array). A velocity correction factor was then calculated for each of the remaining arrays:

$$vcf_i = \frac{v_i}{v_{index}} ; \quad (1)$$

vcf_i is the velocity correction factor for array i ; v_i the velocity over array i ; and v_{index} the velocity over the index array.

Using these correction factors, adjustments for differences in river velocity were made to daily counts for each array:

$$ac_{i,z} = c_{i,z} \cdot vcf_i ; \quad (2)$$

$ac_{i,z}$ are the adjusted counts for array i on day z ; and $c_{i,z}$ the counts for array i on day z .

Counts for each array were actual total counts for all systems but Wood. Four arrays were used at the Wood River site, although the counter was designed to monitor only two. Array I was considered the index array and was continuously monitored. The other three arrays were systematically monitored for 15-min periods. Consequently, the counts for array I were known, while counts for arrays II, III, and IV were estimated:

$$\hat{hc}_{i,z,k} = \sum_{l=1}^p (pc_{i,z,k,l} \cdot \frac{4}{p}) , \text{ and} \quad (3)$$

$$\hat{c}_{i,z} = \sum_{k=1}^{24} \hat{hc}_{i,z,k} ; \quad (4)$$

$\hat{hc}_{i,z,k}$ are estimated counts for array i , day z , and hour k ; $pc_{i,z,k,l}$ the period sonar count for array i , day z , hour k , and counting period l ; and p the number of 15 minute periods that array i was monitored during hour k and day z . If an array was not monitored within the hour, the count was linearly interpolated using the estimated count from the previous hour before and the following hour.

Estimated $\hat{c}_{i,z}$ for Wood River is then substituted into equation 2. The width of river monitored by each array depended on array length (3.03 m), water depth over the array, and transducer signal beam width:

$$l_{i,z} = 3.03 + 2 \left(d_{i,z} \cdot \tan \frac{bw}{2} \right) ; \quad (5)$$

$l_{i,z}$ is the width of river monitored by array i on day z ; $d_{i,z}$ the water depth over array i on day z ; and bw the transducer beam width, in degrees (18 degrees for Kvichak transducers; 9 degrees for transducers at all other rivers).

Sonar arrays were placed perpendicular to the river current at selected intervals across the river. Distances from each array to a reference location on one of the river banks were measured with a marked length of line, and the most inshore and most offshore points of smolt passage were determined with a separate hydroacoustics system consisting of a single side-facing transducer and a control unit. At sites where three arrays were used, distances between the following locations were calculated: (1) inshore limit of smolt passage to first array (D_1); (2) first to second array (D_2); (3) second to third array (D_3); (4) third array to offshore limit of smolt passage (D_4).

Given these distances and measures of fish biomass at points along the river bottom ($ac_{i,z}$ for each array and the inshore and offshore limits of smolt passage), the biomass of fish passing the counting site was estimated as follows:

$$\begin{aligned} \hat{B}_z = & \frac{1}{2} D_1 \cdot \frac{ac_{1,z}}{l_{1,z}} + \sum_{i=1}^{na-1} \frac{1}{2} D_i \left(\frac{ac_{i,z}}{l_{i,z}} + \frac{ac_{i+1,z}}{l_{i+1,z}} \right) \\ & + \frac{1}{2} D_{na+1} \left(\frac{ac_{na,z}}{l_{na,z}} \right) ; \end{aligned} \quad (6)$$

\hat{B}_z is the estimated biomass on day z ; D_i the distance for interval i ; and na the number of transducer arrays used.

Smolt Sampling

Fyke nets were fished on each river to collect age, weight in grams, and fork length in millimeters from smolt migrating past each counting site. Attempts were made to collect 400 smolt each day so that age composition could be estimated, based on sampling for binomial proportions, with a precision of 0.05 and a probability of Type I error of 0.05 (Cochran 1977). If a daily sample of 400 smolt was not obtained, samples were combined with those from subsequent days until a total of 400 smolt were obtained. Since great differences in age composition have been found among different samples of smolt collected during the same day, the daily sample of 400 smolt was obtained from four different fyke net catches throughout each day.

To reduce the time and cost for data collection, age, weight, and length data were obtained from 100 smolt each day, while age and weight were estimated for the remaining 300 smolt, which were measured only for length. Weight-length relationships were calculated for each age group using paired weight-length data from smolt sampled for all three parameters (Ricker 1975):

$$W_j = a \cdot L_j^b ; \quad (7)$$

W_j is the weight of an age j smolt; and L_j the measured fork length of an age j smolt.

Smolt sampled for length only were assigned an age based on a discriminant function developed by D.M. Eggers (Alaska Department of Fish and Game, unpublished data) and a weight based on the appropriate age specific weight-length relationship.

Due to the variability of age composition estimates among subsamples taken the same day, daily mean weight and age proportions were estimated as the mean of subsampled values:

$$\hat{W} = \frac{\sum_{k=1}^m \left(\frac{\sum w_k}{n_k} \right)}{m} ; \quad (8)$$

\hat{W} is the estimated mean weight of smolt during a sample period; m the number of subsamples collected during a sampling period; w_k the observed weights from subsample k ; and n_k the number of observations in subsample k ; and

$$\hat{P}_j = \frac{\sum_{k=1}^m \left(\frac{n_{j,k}}{n_k} \right)}{m} ; \quad (9)$$

\hat{P}_j is the estimated proportion of age j during a sample period; and $n_{j,k}$ the number of observations of age j in subsample k .

Smolt Estimate

Numbers of smolt were estimated by combining biomass estimates with data on smolt population parameters. Mean weight of smolt was used to convert estimates of biomass per count into estimates of smolt per count:

$$\hat{SPC} = \frac{BPC}{\hat{W}} ; \quad (10)$$

\hat{SPC} is the estimated number of smolt per sonar count; and BPC the biomass per count.

The estimated number of smolt was the product of smolt per count and estimated biomass:

$$\hat{N}_z = \hat{B}_z \cdot \hat{SPC} ; \quad (11)$$

\hat{N}_z is the estimated number of smolt in population on day z.

The estimated number of smolt were then apportioned by age class:

$$\hat{N}_{j,z} = \hat{N}_z \cdot \hat{P}_j ; \quad (12)$$

$\hat{N}_{j,z}$ is the estimated number of smolt of age j on day z.

Finally, daily estimates of smolt numbers were summed to provide season totals:

$$\hat{N}_{tot} = \sum \hat{N}_z ; \quad (13)$$

\hat{N}_{tot} is the estimated total number of smolt which passed site during season; and

$$\hat{N}_{j,tot} = \sum \hat{N}_{j,z} ; \quad (14)$$

$\hat{N}_{j,tot}$ is the estimated number of smolt of age j which passed the sonar site during the season.

Climatological Data Collection

A small weather station was maintained at each counting site. Observations on sky conditions, wind direction, wind velocity, daily precipitation, air temperature, and water temperature were recorded at 0800 and 2000 hours daily.

RESULTS AND DISCUSSION

Kvichak River

A total of 2,220,754 sonar counts were recorded during the season (Table 1). Forty-four percent of the counts were recorded over the offshore array. There were intermittent high wind problems from 2 June through 4 June and again during the last day and a half of the project. Some interpolation was necessary for missed fishing time. Linear interpolations were made for these days using counts from 1 and 5 June. Peak day of migration was 6 June when over 58,000,000 smolt migrated seaward (43% of the total run). No side scan sonar data was collected this season. Thus smolt distribution across the counting transect was assumed to be the same as in 1985, with the majority of smolt migrating between 6.4 and 73.3 m (21 and 247 ft, respectively) of the south bank. The velocity correction factors remained constant throughout the

season, 0.88, 1.00, and 1.02 for the inshore, center, and offshore arrays, respectively.

Estimated total number of smolt was 136,733,218 (Table 2). Age class composition of the smolt population was estimated to be 61% age-I (1984 brood year) and 39% age-II (1983 brood year). The percentage of age-II smolt was highest early in the project and decreased as the migration continued. Consequently, the estimated smolt per count increased between the beginning and end of counting (Table 3).

Total smolt production from the 1983 brood year spawning escapement of 3,569,982 sockeye salmon was 21.5 smolt per spawner with 23,590,443 age-I smolt migrating to sea in 1985 and 53,260,639 age-II smolt migrating in 1986 (Table 4). Average marine survival for smolt produced by the 1968-82 brood years has been approximately 9.8% for age-I smolt and about 13.2% for age-II smolt (Table 5).

A total of 1,983 smolt were sampled to obtain data on age, length, and weight (Table 6). Mean lengths of age-I and age-II smolt were 88 mm (3.5 in) and 107 mm (4.2 in) respectively. Mean weights of age-I and age-II smolt were 5.5 g (0.19 oz) and 10.4 g (0.37 oz) respectively. An additional 3,892 smolt were sampled for length only (Table 7). Average lengths for both age-I and age-II smolt were slightly less (nonstatistical comparison = NSC) than the long term averages of 88 mm (3.5 in) and 109 mm (4.3 in) respectively (Table 8). Average weights were also slightly smaller than the long term averages of 5.9 g (0.21 oz) and 10.7 g (0.38 oz) respectively.

River and weather conditions were recorded at the sonar site from 18 May through 12 June (Table 9). Ice was not a problem in 1986 although several days of high winds and entrained air precluded counting on several occasions. Mean water temperature during the project was 6.9 °C (range 3.5-8.8 degrees centigrade). The water temperature during the peak of the outmigration from 5 June to 7 June was 7.0-7.3 °C. These figures are compared in Table 10.

Naknek River

A total of 1,429,172 sonar counts were tabulated during the 1986 season, 23 May through 27 June (Table 11). Twelve percent of these counts were registered over the inshore array, with 72 and 16% passing over the center and offshore arrays, respectively. Counts over the offshore array were adjusted to compensate for a malfunctioning transducer beginning on 25 May [actual offshore count was multiplied by 1.111 (10 transducers / 9 operational transducers)]. No side scan data was collected this year. Thus smolt distribution across the counting transect was assumed to be the same as in 1985, with the majority of smolt migrating between the east bank and 80 m (262 ft) offshore.

Although river velocities varied widely, velocity correction factors remained the same throughout the project. The velocities over each array were standardized to the inshore array resulting in correction factors of 1.00, 1.44, and 0.87 for the inshore, center and offshore arrays, respectively.

The final sockeye salmon smolt population estimate was 41,329,355 (Table 12). Age composition was 53.6% age-I (1984 Brood year), 46.3% age-II (1983 brood year), and 0.1% age-III (1982 brood year). Age-II and III smolt migrated to sea earlier in the season than age-I smolt. Consequently, numbers of smolt per sonar count increased as the season progressed (range, 2.7 to 4.4 smolt per count) (Tables 12 and 13). Total smolt production from the 1982 brood year was 39.4 smolt per spawner. This was slightly less than estimated for the 1980 and 1981 brood years, 50.2 and 47.7, respectively (Table 14). Estimates of marine survival are still unavailable for the Naknek River due to the small number of years that data has been collected (Table 15).

A total of 2,338 sockeye salmon smolt were sampled for age, weight, and length (AWL) information (Table 16). Mean weights of age-I, II, and III smolt were 9.9, 14.9, and 21.8 g respectively. Mean lengths of age-I, II, and III smolt were 99, 116, and 134 mm, respectively. An additional 8,805 smolt lengths were collected to supplement the age, weight and length sampling. Postseason, the AWL samples were grouped into three groups, those collected through 30 May, those collected from 1 June through 12 June, and those collected after 12 June. An age discriminator based on length was estimated for age-I and II smolts within each group. These discriminators and weight-length relations were used to estimate ages and weights for length samples (Table 17). Average size of all three age classes was smaller (NSC) than historically observed (Table 18).

Weather and river conditions were recorded at the sonar site during 23 May through 28 June (Table 19). Mean air and water temperature during this period was 10.0 °C (range -2.2 to 21.0 °C) and 10.4 °C (range 8.5 to 13.0 °C), respectively. Mean water temperature was similar to what has been historically observed for the past 13 seasons (10.4 vs 10.9 °C) (Table 20).

Egegik River

A total of 3,605,614 sonar counts were tabulated from 18 May through 11 June, 1986 (Table 21). The counts were distributed at 56, 27, and 17% over the inshore, center, and offshore arrays, respectively. No side scan sonar data was collected this season; consequently, lateral smolt distribution data collected in 1985 was used [12.2 (40 ft) and 85.3 m (278 ft) from the west bank at the counting site was considered the inshore and offshore limits, respectively].

River velocity was monitored continuously using a Marsh-McBirney current meter anchored directly behind the center array. The smolt counter was adjusted to account for changes in river velocity. River velocity ranged from 0.49 to 0.61 meters per second over the center array. Velocity correction factors between arrays were checked twice; 0.78, 1.00, and 0.96 for the inshore, center, and offshore arrays, respectively, on 19 May, and 0.86, 1.00, and 0.97 for the inshore, center, and offshore arrays, respectively, on 7 June.

The final estimate of seaward migrating sockeye salmon smolt was 44,197,865 (Table 22). Age composition was estimated at 32.0% age-I (1984 brood year), 68.0% age-II (1983 brood year), and < 0.01% age-III (1982 brood year). The

percentage of age-II smolt was highest early in the project and decreased as the migration continued. Consequently, the estimated smolt per count increased between the beginning and end of counting (Table 23). Coho salmon smolt were captured in fyke net samples, but no estimate of coho salmon numbers was made.

Total smolt production from the 1982 brood year was 27.7 smolt per spawner which was less than the 62.4 and 49.7 smolt per spawner estimated for the 1980 and 1981 brood years, respectively (Table 24). Average marine survival for smolt produced by the 1978-1982 brood years has been approximately 30.3% for age-I smolt and 33.0% for age-II smolt (Table 25).

Table 26 presents data from 1,120 sockeye salmon smolt sampled for age, weight, and length. Seasonal mean weights were 9.0 g (0.32 oz), 15.7 g (0.55 oz), and 22.6 g (0.80 oz) for the age-I, II, and III groups, respectively. Mean lengths were 101 mm (4.0 in), 122 mm (4.8 in), and 140 mm (5.5 in) for ages-I, II, and III, respectively. An additional 3,892 smolt lengths were collected to supplement the age, weight and length sampling. Postseason, the AWL samples were grouped into two groups, those collected through 1 June and those collected after 1 June. An age discriminator based on length was estimated for age-I and II smolts within each group. These discriminators and length-weight relations were used to estimate ages and weights for the length samples (Table 27). Age-I sockeye salmon smolt were smaller (NSC) than the historical average, while both ages II and III were larger (NSC) (Table 28). The coho salmon smolt sampled were predominantly age-II (Table 29).

Weather and river conditions were recorded at the sonar site during 19 May through 12 June (Table 30). Shore ice was present near the western shore of Lake Becharof and ice fragments were floating past the sonar site when observations were begun on 19 May. Ice was present until 25 May, although no difficulty in sampling or sonar operations was attributed to ice. Mean air and water temperature during the project was 7.2 °C (range 0 to 12 °C) and 4.5 °C (range 2.2 to 7.5 °C), respectively. Mean water temperature was higher than the 1981-1985 average (Table 31).

Ugashik River

A total of 4,829,091 sonar counts were tabulated between 21 May and 13 June at the Ugashik site (Table 32). Forty and 60% of the counts were recorded over the inshore and offshore arrays, respectively. Side scan sonar data indicated that the majority of smolt passed between 7.0 and 26.2 meters of the north bank.

River velocity changed slightly during the project. The observed velocities on 22 May were 1.25 m/sec over the inshore array and 1.38 m/sec over the offshore array (4.10 and 4.53 ft/sec, respectively). The velocities were corrected to the inshore array; consequently, the velocity correction factors were 1.00 and 1.10 for the inshore and offshore arrays. The velocities recorded on 4 June were 1.50 and 1.33 m/sec (4.93 and 4.37 ft/sec) for the inshore and offshore arrays, respectively. The correction factors of 1.00, and 0.89 were used for the remainder of the season.

The final estimate of seaward migrating sockeye salmon smolt was 53,076,253 (Table 33). Estimated age composition was 71.4 % age-I (1984 brood year) and 28.6% age-II (1983 brood year). No age-III smolt were observed this season. Age-I smolt were the predominate age group throughout the project. Age-II smolt were in greatest abundance during the middle of the season. The estimated number of smolt per sonar count is summarized in Table 34. Total smolt production from the 1982 brood year was 83.7 smolt per spawner (Table 35). This is similar to the production (85.9) calculated for the 1981 brood year. Average marine survival was not calculated due to the small number of years from which data has been collected (Table 36).

A total of 1,555 sockeye salmon smolt were sampled for age, weight, and length information (Table 37). The mean weight of age-I and age-II smolts was 5.8 g (0.20 oz) and 10.9 g (0.38 oz), respectively. Mean length was 87 mm (3.4 in) and 114 mm (4.0 in) for the age-I and age-II smolts, respectively. An additional 4,257 smolt were sampled for length to supplement the age, weight, and length sampling. Postseason, all AWLs were pooled into a single group to estimate weight-length relationships for both age groups and to estimate the age discriminator based on length (Table 38). Age-I smolt were smaller (NSC) than historically observed while age-II smolt were slightly larger (NSC) (Table 39). No age-III or coho salmon smolt were observed in the samples.

Climatological and hydrological observations were made at the sonar site from 20 May through 14 June (Table 40). Average air temperature for the time period was 7.1 °C (range 0 to 16 °C) with an average water temperature of 5.6 °C (range 2 to 7 °C). Average water temperature was slightly lower than observed for 1983-1985 (6.0 °C) (Table 41).

Wood River

A total of 961,541 sonar counts were tabulated during the 1986 season, 27 May through 15 July (Table 42). Twenty-six percent of these counts were registered over the inshore array, with 36, 21, and 17% passing over the center and offshore arrays, respectively. This pattern was similar to that recorded in past years (Table 43).

No side scan data was collected this year. However lateral smolt distribution across the counting transect was assumed to be a function of river width (and depth) which was measured and recorded every 5 days, at a time when the river was not influenced by tide. Based on the average of these measurements, smolt distribution was assumed to have inshore and offshore limits of 1.5 and 95 m (4.9 and 311.6 ft, respectively) from the north bank, respectively.

The river velocity was monitored continuously using a Marsh-McBirney current meter anchored directly behind the inshore array. Velocity setting on the smolt counter was adjusted at 15-minute intervals to reflect that measured by the current meter. River velocity ranged from 1.10 to 1.58 m/sec over the inshore array. The velocity correction factors used for the remaining three arrays are presented in Table 44.

The final sockeye salmon smolt estimate was 28,064,408 (Table 45). Age composition was 97.9% age-I (1984 brood year) and 2.1% age-II (1983 brood year). The estimated number of smolt per sonar count is summarized in Table 46. Total smolt production from the 1983 brood year was 23.9 smolt per spawner. This was slightly less (NSC) than that estimated for the 1982 brood year (27.6) but higher than the 17.1 estimated in 1981 (Table 47). Smolt survival has been calculated completely for the 1973-80 brood years, and partially for the 1981 and 1982 brood years. Comparisons of adult returns per smolt (survival) by brood year indicates an increase in returns from the 1981 brood year for both age-I and age-II smolts with future adults returns expected to boost these estimates even higher (Table 48).

A total of 5,003 sockeye salmon smolt were sampled for age, weight, and length information (Table 49). Mean weights of age-I and II smolt were 5.9 g (0.21 oz) and 9.2 g (0.32 oz), respectively. Mean lengths of age-I and II smolt were 87 mm (3.4 in) and 101 mm (4.0 in), respectively. Mean length and weight of age-I smolt was greater (NSC) than the (1951-85) mean [84 mm (3.3 in) and 6.0 g (0.21 oz)]. However, mean length and weight of age-II smolt was less than the long-term mean [100 mm (3.9 in) and 8.5 g (0.30 oz)] (Table 50). Infection by *Triacnophorus crassus* was greater for age-II smolt (45.6%) than for age-I smolt (40.8%) (NSC) (Table 51). The incidence of *T. crassus* has greatly increased since 1983 (NSC) (Table 52).

Weather and river conditions were recorded at the sonar site during 24 May through 15 July (Table 53). The mean water temperature during this period was 6.1 °C (range 3.0 to 10.5 °C). Although this was 2.3 °C colder than the historic (1975-85) mean (8.4 °C), it should be noted that the project normally is operated until the first week in August. The shorter season in 1986 may account for the cooler (mean) water temperature since higher temperatures are usually recorded in the latter part of the season (Table 54).

Nuyakuk River

A total of 164,940 sonar counts were tabulated from 25 May through 27 June, 1986 (Table 55). The counts were distributed at 30, 38, and 32% over the inshore, center, and offshore arrays, respectively. Side scan sonar data indicated that the majority of smolt passed within 12.2 and 92.7 m (40.0 and 304 ft) from the south bank.

River velocity over the inshore array was measured daily at 1200 hours. The smolt counter was adjusted to account for changes in river velocity over the inshore array. River velocity ranged from 0.34 to 1.31 m/sec (1.12 to 4.30 ft/sec) over the inshore array. Velocity correction factors between arrays were checked weekly.

The final estimate of seaward migrating sockeye salmon smolt was 11,236,164 (Table 56). Age composition was estimated at 98.5% age-I (1984 brood year) and 1.5% age-II (1983 brood year). The estimated number of smolt per count remained relatively constant throughout the season (Table 57). Chinook salmon smolt were collected in fyke net samples but no estimate of chinook numbers was made.

Total smolt production from the 1983 brood year (71.4 smolt per spawner) was more than twice that previously observed (34.7 smolt per spawner from the 1981 brood year) (Table 58). Marine survival was not calculated due to the small number of years from which data is available (Table 59).

Table 60 presents data from 1,840 sockeye salmon smolt sampled for age, weight, and length (Table 60). Seasonal mean weights were 4.7 g (0.17 oz), and 6.3 g (0.22 oz) for age-I and II smolt, respectively. Mean lengths were 81 mm (3.2 in) for age-I and 91 mm (3.6 in) for age-II smolt. An additional 1,922 smolt lengths were collected to supplement the age, weight and length sampling. Postseason, the AWL samples were grouped into one group. An age discriminator based on length and weight-length relationships were estimated for age-I and II smolts. This discriminator and weight-length relationships were used to estimate ages and weights for the length samples (Table 61). Age-I sockeye salmon smolt were larger than the historical average (NSC), while age-II were similar (Table 62). The chinook salmon smolt sampled were predominantly age-I (Table 63).

Weather and river conditions were recorded at the sonar site during 25 May through 27 June (Table 64). Nuyakuk Lake was covered with ice when the sonar project began, but melted in place during the first two weeks of operations. Mean air and water temperature during the project was 10.9 °C (range 5 to 31 °C) and 6.8 °C (range 4.5 to 12.0 °C), respectively.

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TABLES

Table 1. Sonar counts recorded from three 14 transducer arrays at the sockeye salmon smolt counting site on the Kvichak River, Bristol Bay, Alaska, 1986.

Sonar Counts				
Transducer Array				
Date ^a	Inshore	Center	Offshore	Total
5 21	709	523	415	1647
5 22	448	3153	6147	9748
5 23	9279	17574	5571	32424
5 24	16265	52788	35462	104515
5 25	15873	52340	11629	79842
5 26	6910	2436	2738	12084
5 27	47879	86560	32541	166980
5 28	22624	29410	29752	81786
5 29	18521	57371	24498	100390
5 30	15379	31402	17026	63807
5 31	19327	60709	69411	149447
6 1	16297	21571	13152	51020
6 2 ^b	9751	11654	7469	28874
6 3 ^b	3215	1738	1786	6739
6 4 ^b	93852	54665	22883	171400
6 5	39455	26774	61710	127939
6 6	73602	218763	524434	816799
6 7	40499	41950	72583	155032
6 8	3055	2283	11116	16454
6 9	5465	8341	6360	20166
6 10	3215	1772	6845	11832
6 11 ^b	2142	1182	4562	7886
6 12 ^b	1071	591	2281	3943
Total	464,833	785,550	970,371	2,220,754
Percent	20.93	35.37	43.70	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

^b Interpolated data.

Table 2. Daily number of sockeye salmon smolt migrating seaward in the Kvichak River, Bristol Bay, Alaska, 1986, as estimated with a sonar unit.

Date ^a	Age I			Age II			Age III			All Ages	
	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
5 21	20,557	27.96	20,557	52,966	72.04	52,966	0	0	0	73,523	73,523
5 22	120,574	27.96	141,131	310,665	72.04	363,631	0	0	0	431,239	504,762
5 23	373,243	25.54	514,374	1,088,164	74.46	1,451,795	0	0	0	1,461,407	1,966,169
5 24	1,191,175	25.54	1,705,549	3,472,785	74.46	4,924,580	0	0	0	4,663,960	6,630,129
5 25	646,213	17.02	2,351,762	3,150,574	82.98	8,075,154	0	0	0	3,796,787	10,426,916
5 26	90,902	17.02	2,442,664	443,187	82.98	8,518,341	0	0	0	534,089	10,961,005
5 27	1,321,830	17.02	3,764,494	6,444,506	82.98	14,962,847	0	0	0	7,766,336	18,727,341
5 28	2,077,767	45.47	5,842,261	2,491,767	54.53	17,454,614	0	0	0	4,569,534	23,296,875
5 29	2,255,563	41.01	8,097,824	3,244,469	58.99	20,699,083	0	0	0	5,500,032	28,796,907
5 30	1,810,520	49.80	9,908,344	1,825,062	50.20	22,524,145	0	0	0	3,635,582	32,432,489
5 31	4,162,537	49.80	14,070,881	4,195,971	50.20	26,720,116	0	0	0	8,358,508	40,790,997
6 1	2,368,057	70.26	16,438,938	1,002,363	29.74	27,722,479	0	0	0	3,370,420	44,161,417
6 2	1,083,657	60.22	17,522,595	715,840	39.78	28,438,319	0	0	0	1,799,497	45,960,914
6 3	247,074	60.22	17,769,669	163,211	39.78	28,601,530	0	0	0	410,285	46,371,199
6 4	6,367,841	60.22	24,137,510	4,206,455	39.78	32,807,985	0	0	0	10,574,296	56,945,495
6 5	4,763,208	62.08	28,900,718	2,909,485	37.92	35,717,470	0	0	0	7,672,693	64,618,188
6 6	45,777,759	78.13	74,678,477	12,814,022	21.87	48,531,492	0	0	0	58,591,781	123,209,969
6 7	5,546,361	59.69	80,224,838	3,745,582	40.31	52,277,074	0	0	0	9,291,943	132,501,912
6 8	939,260	79.76	81,164,098	238,347	20.24	52,515,421	0	0	0	1,177,607	133,679,519
6 9	1,215,078	79.76	82,379,176	308,339	20.24	52,823,760	0	0	0	1,523,417	135,202,936
6 10	633,255	77.43	83,012,431	184,587	22.57	53,008,347	0	0	0	817,842	136,020,778
6 11	305,353	64.29	83,317,784	168,231	35.42	53,176,578	1377	.29	1377	474,961	136,495,739
6 12	152,676	64.29	83,470,460	84,115	35.42	53,260,693	688	.29	2065	237,479	136,733,218
Total	83,470,460	61.05		53,260,693	38.95		2,065	0.00		136,733,218	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 3. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolts, Kvichak River, Bristol Bay, Alaska, 1986.

Date ^a	Mean Weight of Smolt (g)	Smolt per Count
5 21	10.0	8.3
5 22	10.0	8.3
5 23	10.3	8.1
5 24	10.3	8.1
5 25	9.9	8.4
5 26	9.9	8.4
5 27	9.9	8.4
5 28	8.0	10.3
5 29	8.5	9.8
5 30	8.1	10.3
5 31	8.1	10.3
6 1	6.9	12.1
6 2	7.3	11.4
6 3	7.3	11.4
6 4	7.3	11.4
6 5	7.3	11.4
6 6	6.1	13.6
6 7	7.4	11.3
6 8	6.0	13.9
6 9	6.0	13.9
6 10	6.2	13.3
6 11	7.2	11.6
6 12	7.2	11.6

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 4. Sockeye salmon spawning escapement, total number of smolt produced by age class (percent of total smolt production comprised by each age class indicated within parentheses), and number of smolt produced per spawner for 1956-1984 brood years, Kvichak River, Bristol Bay, Alaska.

Brood Year	Total Spawning Escapement	Number of Smolt Produced				
		Age I	Age II	Age III	Total	Per Spawner
<u>Estimates of smolt numbers based upon fyke net catches</u>						
1956	9,443,318	3,267,274 (54)	2,777,960 (46)	0	6,045,234	0.640
1957	2,842,810	85,916 (13)	552,603 (87)	0	638,519	0.225
1958	534,785	61,400 (86)	10,126 (14)	0	71,526	0.134
1959	680,000	26,038 (27)	72,180 (73)	0	98,218	0.144
1960	14,630,000	1,130,820 (22)	4,116,093 (78)	0	5,246,913	0.359
1961	3,705,849	113,338 (7)	1,603,464 (93)	0	1,716,802	0.463
1962	2,580,884	458,122 (21)	1,748,178 (79)	0	2,206,300	0.855
1963	338,760	64,377 (73)	23,377 (27)	0	87,754	0.259
1964	957,120	252,384 (53)	222,528 (47)	0	474,912	0.496
1965	24,325,926	2,866,214 (34)	5,475,362 (66)	0	8,341,576	0.343
1966	3,775,184	648,321 (55)	541,017 (45)	0	1,189,338	0.315
1967	3,216,208	594,327 (67)	298,282 (33)	0	892,609	0.278
1968	2,557,440	185,356				
<u>Estimates of smolt numbers based upon sonar techniques</u>						
1968			5,959,383	0	-	-
1969	8,394,204	85,723,430 (61)	54,159,340 (39)	0	139,882,770	16.664
1970	13,935,306	464,219 (<1)	191,842,930 (98)	2,918,768 (1)	195,225,917	14.009
1971	2,387,392	5,123,400 (19)	21,423,246 (81)	0	26,546,646	11.120
1972	1,009,962	2,740,610	-	-	-	-
1973	226,554	-	3,031,287	0	-	-
1974	4,433,844	108,356,892 (49)	114,269,848 (51)	0	222,626,740	50.211

-Continued-

Table 4. (Page 2 of 2)

Brood Year	Total Spawning Escapement	Number of Smolt Produced				
		Age I	Age II	Age III	Total	Per Spawner
<u>Estimates of smolt numbers based upon sonar techniques</u>						
1975	13,140,450	78,308,251 (27)	213,364,470 (73)	0	291,672,721	22.197
1976	1,965,282	32,226,544 (55)	26,423,348 (45)	0	58,649,892	29.843
1977	1,341,144	28,758,191 (73)	10,410,467 (27)	0	39,168,658	29.205
1978	4,149,288	182,442,540 (85)	32,294,536 (15)	0	214,737,076	51.753
1979	11,218,434	219,928,232 (71)	89,300,703 (29)	0	309,228,935	27.564
1980	17,505,268	150,421,026 (62)	76,244,773 (38)	0	199,172,858	12.948
1981	1,754,358	6,549,125 (15)	37,595,987 (85)	0	44,145,112	25.163
1982	1,134,840	51,893,988 (96)	1,937,408 (4)	2,065	53,833,461	47.437
1983	3,569,982	23,590,443 (31)	53,260,693 (69)		76,851,136 ^a	21.527
1984	10,490,670	83,470,460				

^a Preliminary total

Table 5. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1952-1984 brood years, Kvichak River, Bristol Bay, Alaska.

Brood Year	Total ^a Spawning Escapement	Age I			Age II		
		Number of Smolt	Adult ^a Returns	Adult Returns per Smolt	Number of Smolt	Adult ^a Returns	Adult Returns per Smolt
<u>Estimates of smolt numbers based upon fyke net catches</u>							
1952	-	-			241,870	3,610,258	14.93
1953	-	18,198	152,165	8.36	47,373	424,627	8.96
1954	-	30,287	109,965	3.63	8,654	659,246	76.18
1955	-	22,253	351,240	15.78	66,679	1,132,813	16.99
1956	9,443,318	3,267,274	31,253,977	9.57	2,777,960	7,773,131	2.80
1957	2,842,810	85,916	488,844	5.69	552,603	3,591,552	6.50
1958	534,785	61,400	124,250	2.02	10,126	161,253	15.92
1959	680,000	26,038	328,287	12.61	72,180	217,593	3.01
1960	14,630,000	1,130,820	1,877,221	1.66	4,116,093	53,360,190	12.96
1961	3,705,849	113,338	524,416	4.63	1,603,464	2,971,816	1.85
1962	2,580,884	458,122	256,253	0.56	1,748,178	5,083,162	2.91
1963	338,760	64,377	98,571	1.53	23,377	1,008,242	43.13
1964	957,120	252,384	2,647,042	10.49	222,528	3,093,042	13.90
1965	24,325,926	2,866,214	10,349,415	3.61	5,475,362	34,671,692	6.33
1966	3,775,184	648,321	1,594,186	2.46	541,017	4,657,432	8.61
1967	3,216,208	594,327	621,690	1.05	298,282	900,307	3.02
1968	2,557,440	185,356	332,177	1.79	-		

-Continued-

Table 5. (Page 2 of 2)

Brood Year	Total ^a Spawning Escapement	Age I			Age II		
		Number of Smolt	Adult ^a Returns	Adult Returns per Smolt	Number of Smolt	Adult ^a Returns	Adult Returns per Smolt
<u>Estimates of smolt numbers based upon sonar techniques</u>							
1968	2,557,440	-			5,959,383	209,105	0.04
1969	8,394,204	85,723,430	449,876	0.01	54,159,340	4,823,046	0.09
1970	13,935,306	464,219	56,805	0.12	191,842,930	15,350,282	0.08
1971	2,387,392	5,123,400	337,402	0.07	21,423,246	2,490,225	0.12
1972	1,009,962	2,740,610	436,664	0.16	-	1,504,342	-
1973	226,554	-	1,607,253	-	3,031,287	818,392	0.27
1974	4,433,844	108,356,892	8,353,688	0.08	114,269,848	17,797,272	0.16
1975	13,140,450	78,308,251	6,919,726	0.09	213,364,470	31,164,419	0.15
1976	1,965,282	32,226,544	6,132,602	0.19	26,423,348	4,431,287	0.17
1977	1,341,144	28,758,191	2,910,136	0.10	10,410,467	307,905	0.03
1978	4,149,288	182,442,540	2,989,871	0.02	32,294,536	2,169,833	0.07
1979	11,218,434	219,928,232	20,631,921	0.09	89,300,703	21,194,617	0.24
1980	22,505,268	150,421,026	4,536,972	0.03	76,244,773	8,527,417	0.11
1981	1,754,358	6,549,125	1,034,266	0.16	37,595,987	1,143,597	0.03 ^b
1982	1,134,840	51,893,988	936,358	0.02	1,937,408	556,002	0.29 ^b
1983	3,569,982	23,590,443	951	0.00 ^b	53,260,693		
1984	10,490,670	83,470,460					

^a Includes interception estimates, Yuen and Nelson (1987)

^b Future adult returns will increase these values.

Table 6. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Kvichak River, Bristol Bay, Alaska, 1986.

Date ^a	Age I					Age II					Age III				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
5 21	87	3.3	6.1	.74	6	112	14.0	12.6	3.84	24					
5 22	86	12.4	6.0	2.49	32	108	17.6	11.1	5.16	41					
5 23	90	7.2	8.7	2.75	20	110	22.6	11.7	5.27	68					
5 24	85	10.3	5.7	2.13	35	110	20.6	12.4	7.27	55					
5 25	89	9.4	6.3	1.72	17	106	16.3	10.0	3.99	43					
5 26					0	108	15.1	10.8	4.44	64					
5 27	85	13.1	5.7	2.41	35	105	16.8	10.2	4.92	85					
5 28	86	12.4	5.9	2.15	34	104	17.4	9.8	4.77	56					
5 29	83	11.0	5.4	1.84	64	106	18.5	9.9	5.27	56					
5 30	85	8.7	5.2	1.78	28	107	14.2	10.6	4.23	31					
5 31	84	10.5	5.4	2.24	68	104	13.4	9.8	3.49	52					
6 1	83	11.4	5.3	2.01	84	106	14.6	10.4	4.21	35					
6 2	80	18.8	4.6	2.80	33	111	27.0	11.2	7.70	26					
6 3	85	7.8	5.4	1.42	45	103	13.6	9.2	3.47	15					
6 4	85	8.0	5.5	2.28	28	103	14.4	9.7	3.91	32					
6 5	84	8.8	5.0	1.78	61	109	13.0	10.5	3.74	29					
6 6	83	13.4	4.9	2.09	93	108	16.0	10.1	3.96	27					
6 7	83	11.6	4.9	2.44	107	109	19.2	10.7	5.15	43					
6 8	82	13.3	4.6	2.31	80	102	11.2	7.9	3.15	9					
6 9	82	12.5	4.8	2.24	78	107	11.2	10.1	3.17	12					
6 10	83	10.4	5.1	2.08	101	104	12.0	10.0	3.06	18					
6 11	83	8.6	4.8	1.65	63	108	14.6	10.3	4.43	22					
6 12	81	6.5	5.3	1.28	16	110	15.1	11.3	3.52	11	102		9.1		1
Totals					1,128					854					1
Means	88		5.5			107		10.4			102		9.1		

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 7. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Kvichak River, Bristol Bay, Alaska, 1986.

Date ^a	Estimated Age I				Estimated Age II			
	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size
5 21 ^b	88	5.5	6.6	14	111	18.8	11.8	86
5 22	86	9.8	6.1	58	108	28.7	11.1	142
5 23	86	9.7	6.1	44	109	28.8	11.5	257
5 24	85	10.6	5.9	104	110	29.7	11.6	191
5 25	87	6.2	6.2	46	103	19.9	9.8	91
5 26	83	.0	5.4	1	108	19.2	11.1	135
5 27	83	17.4	5.3	136	107	25.7	10.7	323
5 28	85	13.4	5.6	158	104	24.3	9.8	196
5 29	85	15.5	5.5	178	105	24.3	9.9	216
5 30	84	10.1	5.4	96	108	23.3	10.8	135
5 31 ^c	85	14.5	5.5	282	104	21.9	9.6	183
6 1	83	14.7	5.1	312	105	17.5	9.7	111
6 2	85	8.4	5.4	57	116	19.3	12.7	48
6 3	85	10.8	5.3	108	106	22.9	10.1	41
6 4	85	12.8	5.3	133	104	22.3	9.4	96
6 5	83	15.0	5.0	323	107	20.2	10.1	102
6 6	82	19.7	4.8	437	107	25.5	10.1	91
6 7	83	17.4	4.9	442	107	29.1	10.3	260
6 8	82	13.9	4.8	191	102	11.8	8.9	10
6 9	82	15.3	4.8	253	110	18.8	10.8	45
6 10	83	14.1	4.9	373	103	18.5	9.2	92
6 11	81	11.1	4.7	173	106	18.3	10.0	19
6 12	82	6.2	4.9	20	116	14.9	12.6	9
Totals				1543				2349
Means	100		8.6		120		14.7	

-Continued-

Table 7. (Page 2 of 2)

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- ^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.
- ^b Length-weight parameters by age group and discriminating length used to separate ages for 21 May through 30 May were;
age I $a = -9.42$ $b = 2.50$ $r^2 = .69$ $n = 273$
age II $a = -10.13$ $b = 2.66$ $r^2 = .83$ $n = 521$
discriminating length = 93.5
- ^c Length-weight parameters by age group and discriminating length used to separate ages for 31 May through 12 June were;
age I $a = -10.92$ $b = 2.83$ $r^2 = .77$ $n = 882$
age II $a = -10.44$ $b = 2.73$ $r^2 = .85$ $n = 334$
discriminating length = 92.5

Table 8. Age composition of total migration, and mean fork length and weight by age class, for sockeye salmon smolt, Kvichak River, Bristol Bay, Alaska, 1955-1986.

Year of Migration	Age I			Age II			Age III			Total Estimate	References
	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)		
1955 ^a	7	89	-	93	-	-	0	-	-	260,068	Paulus and Parker (1974)
1956 ^a	39	92	-	61	116	-	0	-	-	77,660	"
1957 ^a	72	96	7.3	28	120	14.4	0	-	-	30,907	"
1958 ^a	98	84	4.6	2	114	-	0	-	-	3,333,953	"
1959 ^a	3	80	-	97	99	7.6	0	-	-	2,863,876	"
1960 ^a	10	91	6.3	90	108	10.3	0	-	-	614,003	"
1961 ^a	72	92	6.8	28	117	13.1	0	-	-	36,164	"
1962 ^a	94	82	4.3	6	110	9.9	0	-	-	1,203,000	"
1963 ^a	3	83	4.8	97	98	7.5	0	-	-	4,229,431	Marriott (1965)
1964 ^a	22	87	5.2	78	108	9.8	0	-	-	2,061,586	Pennoyer and Seibel (1965)
1965 ^a	4	90	6.8	96	109	11.3	0	-	-	1,812,555	Pennoyer (1966)
1966 ^a	92	94	7.4	8	114	12.6	0	-	-	275,761	Pennoyer and Stewart (1967)
1967 ^a	93	86	5.9	7	118	14.2	0	-	-	3,088,742	Pennoyer and Stewart (1969)
1968 ^a	11	88	5.5	89	104	9.2	0	-	-	6,123,683	Paulus and McCurdy (1969)
1969 ^a	52	92	5.7	48	109	10.6	0	-	-	1,135,344	McCurdy and Paulus (1972)
1970 ^a	38	91	6.0	62	110	11.0	0	-	-	483,638	Paulus and McCurdy (1972)
1971 ^b	93	90	5.8	7	111	11.1	0	-	-	91,682,813	Russell (1972)
1972 ^b	1	80	4.2	99	106	10.0	0	-	-	54,623,559	Parker (1974a)
1973 ^b	3	86	5.1	97	97	8.3	0	-	-	196,966,331	Parker (1974b)
1974 ^b	9	96	8.3	79	111	13.1	12	124	17.5	27,082,626	Krasnowski (1975)
1975 ^b	63	98	8.4	37	122	16.4	0	-	-	15,632,531	Randall (1976)
1976 ^b	97	88	5.8	3	121	14.2	0	-	-	111,388,180	Randall (1977)
1977 ^b	38	86	5.5	62	106	10.1	0	-	-	192,578,099	Randall (1978)
1978 ^b	12	88	6.0	88	97	7.8	0	-	-	245,591,014	Yuen (1980a)

-Continued-

Table 8. (Page 2 of 2)

Year of Migration	Age I			Age II			Age III			Total Estimate	References
	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)		
1979 ^b	51	90	6.0	49	109	10.3	0	-	-	55,181,540	Yuen (1980b)
1980 ^b	94	88	5.9	6	110	10.7	0	-	-	192,853,007	Yuen and Wise (1982)
1981 ^b	89	85	5.4	11	108	10.2	0	-	-	252,222,769	Bergstrom and Yuen (1981)
1982 ^b	58	84	5.1	39	103	9.1	0	-	-	239,721,729	Bill (1984)
1983 ^b	8	80	4.9	92	98	8.5	0	-	-	82,793,899	Bill et al. (1987)
1984 ^b	58	90	6.8	42	104	10.0	0	-	-	89,489,975	Bill (1986)
1985 ^b	92	85	5.3	8	102	9.2	0	-	-	25,527,851	Bill (1986)
		—	—		—	—		—	—		
	Mean	88	5.9		109	10.7		124	17.5		
1986 ^b	61	84	5.5	39	107	10.4	0	102	9.1		

^a Estimate of smolt numbers based on fyke net catches

^b Estimate of smolt numbers based on sonar techniques

Table 9. Climatological and hydrological observations made at sockeye salmon smolt counting site, Kvichak River, Bristol Bay, Alaska, 1986.

Date	Cloud Cover ^a		Wind Velocity (km/h)		Air Temp. (°C)		Mean Water Temp. (°C)	Water Clarity
	0800 hr	2000 hr	0800 hr	2000 hr	Min	Max		
5 18	5	1	5 N	5 N	2.2	-	5.0	clear
5 19	4	2	10 SW	15 SW	-0.6	-	3.5	clear
5 20	4	3	5 S	calm	1.7	-	4.0	clear
5 21	1	1	calm	calm	-	-	4.5	clear
5 22	1	2	calm	25 NE	1.1	10.0	5.8	clear
5 23	1	1	15 NE	10 E	3.3	13.3	6.3	clear
5 24	1	3	5 SE	calm	1.1	18.9	6.5	clear
5 25	1	3	calm	10 E	3.3	12.8	6.8	clear
5 26	1	1	calm	10 NW	3.3	16.7	7.3	clear
5 27	1	1	calm	7 N	3.3	16.7	7.3	clear
5 28	1	1	5 NE	5 N	5.0	20.0	7.8	clear
5 29	1	3	calm	15 W	-	13.3	7.9	clear
5 30	4	4	10 NE	10 NE	8.9	9.4	8.0	clear
5 31	3	2	10 NE	5 S	5.6	10.0	7.8	turbid
6 1	3	4	5 NE	5 E	6.1	8.9	7.5	clear
6 2	2	4	5 NE	35 E	5.0	8.3	7.0	clear
6 3	4	4	30 NE	35 E	5.6	-	7.0	turbid
6 4	4	4	15 E	calm	-	-	6.7	turbid
6 5	4	3	5 SW	calm	7.8	-	7.3	turbid
6 6	3	4	25 NW	10 NE	7.8	8.9	7.0	turbid
6 7	4	4	15 NE	5 NE	8.3	12.2	7.0	lt.brn.
6 8	4	3	5 NE	15 NE	6.7	-	7.5	lt.brn.
6 9	2	2	5 NE	10 NE	-	11.1	8.0	turbid
6 10	5	3	5 SW	10 N	3.3	12.8	8.5	lt.brn.
6 11	2	4	10 E		7.8	12.2	8.8	lt.brn.
6 12	4				6.7	-	8.0	turbid

- ^a
- 1 = cloud cover not more than 1/10
 - 2 = cloud cover not more than 1/2
 - 3 = cloud cover more than 1/2
 - 4 = completely overcast
 - 5 = fog

Table 10. Water temperatures at sockeye salmon smolt counting site, Kvichak River, Bristol Bay, Alaska, 1963-1986.

Year	Sample Period	Water Temperature (°C)			
		Minimum	Maximum	Mean	
1963	16 May-14 June	2.2	8.9	5.5	Marriott (1965)
1964	18 May-14 June	0.0	5.6	2.6	Pennoyer and Seibel (1965)
1965	17 May-11 June	0.0	8.9	4.4	Pennoyer (1966)
1966	16 May-26 June	0.0	11.1	4.7	Pennoyer and Stewart (1967)
1967	17 May-20 June	1.1	9.4	6.9	Pennoyer and Stewart (1969)
1968	12 May-12 June	3.3	8.3	5.4	Paulus and McCurdy (1969)
1969	16 May-18 June	0.3	7.8	3.9	McCurdy and Paulus (1972)
1970	13 May- 7 June	2.8	11.1	6.8	Paulus and McCurdy (1972)
1971	17 May-20 June	1.1	3.3	2.4	Russell (1972)
1972	18 May-18 June	0.6	5.0	2.9	Parker (1974a)
1973	15 May-14 June	2.9	8.9	4.9	Parker (1974b)
1974	13 May- 9 June	3.0	8.0	6.2	Krasnowski (1975)
1975	17 May-15 June	2.0	8.0	3.8	Randall (1976)
1976	18 May-19 June	2.0	9.5	3.9	Randall (1977)
1977	17 May-14 June	3.0	9.5	6.4	Randall (1978)
1978	19 May- 9 June	5.0	11.0	7.6	Yuen (1980a)
1979	1 June-10 June	8.0	10.0	8.6	Yuen (1980b)
1980	16 May-18 June	1.5	9.0	5.5	Bergstrom and Yuen (1981)
1981	15 May- 9 June	7.0	10.0	8.2	Yuen and Wise (1982)
1982	14 May-15 June	2.5	8.5	4.9	Bill (1984)
1983	19 May-14 June	5.2	10.5	7.9	Bill et al. (1987)
1984	19 May-11 June	5.5	10.0	7.9	Bill (1986)
1985	23 May-20 June	2.0	7.0	4.6	Bill (1986)
Mean		2.7	8.7	5.5	
1986	18 May-12 June	1.0	7.0	4.6	

Table 11. Sonar counts recorded from three 10 transducer arrays at the sockeye salmon smolt counting site on the Naknek River, Bristol Bay, Alaska, 1986.

Sonar Counts				
Transducer Array				
Date ^a	Inshore	Center	Offshore	Total
5 23	0	0	0	0
5 24	13	86	41	140
5 25	0	15	72	87
5 26	466	1,906	124	2,496
5 27	2,912	7,979	537	11,428
5 28	2,711	14,594	171	17,476
5 29	1,614	27,045	4,308	32,967
5 30	3,393	16,178	10,847	30,418
5 31	657	12,899	2,036	15,592
6 1	3,081	68,317	20,755	92,153
6 2	1,137	124,635	22,632	148,404
6 3	11,962	79,652	25,036	116,650
6 4	9,639	16,648	3,676	29,963
6 5	2,267	25,492	5,177	32,936
6 6	3,685	38,837	7,582	50,104
6 7	1,160	28,170	3,696	33,026
6 8	812	14,075	5,805	20,692
6 9	1,948	6,659	853	9,460
6 10	3,796	2,933	270	6,999
6 11	5,858	30,530	5,674	42,062
6 12	7,921	58,132	11,079	77,132
6 13	9,983	85,733	16,484	112,200
6 14	968	31,697	6,769	39,434
6 15	12,861	11,837	606	25,304
6 16	11,217	19,922	5,166	36,305
6 17	8,785	16,900	3,293	28,978
6 18	1,095	23,373	1,610	26,078
6 19	1,414	38,778	1,667	41,859
6 20	5,818	77,662	18,997	102,477
6 21	7,525	86,675	28,945	123,145
6 22	13,868	22,196	6,885	42,949
6 23	4,197	7,347	1,020	12,564

- Continued -

Table 11. (Page 2 of 2)

Sonar Counts				
Transducer Array				
Date ^a	Inshore	Center	Offshore	Total
6 24	16,467	24,951	1,224	42,642
6 25	15,209	1,809	453	17,471
6 26	680	1,590	160	2,430
6 27	333	4,456	362	5,151
Total	175,452	1,029,708	224,012	1,429,172
Percent	12.28	72.05	15.67	1.00

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 12. Daily number of sockeye salmon smolt migrating seaward in the Naknek River, Bristol Bay, Alaska, 1986, as estimated with a sonar unit.

Date ^a	Age I		Age II		Age III		All Ages	
	Number	Percent	Number	Percent	Number	Percent	Daily Total	Cumulative Total
5 23	0		0		0		0	0
5 24	151	4.94	2,904	94.70	11	.36	3,066	3,066
5 25	78	4.94	1,502	94.70	5	.36	1,585	4,651
5 26	2,813	4.94	53,926	94.70	204	.36	56,943	61,594
5 27	12,327	4.94	236,325	94.70	898	.36	249,550	311,144
5 28	20,421	4.94	391,484	94.70	1,488	.36	413,393	724,537
5 29	37,283	4.94	714,723	94.70	2,717	.36	754,723	1,479,260
5 30	30,834	4.94	591,100	94.70	2,247	.36	624,181	2,103,441
5 31	37,759	9.54	356,576	90.09	1,464	.37	395,799	2,499,240
6 1	218,014	9.54	2,058,798	90.09	8,455	.37	2,285,267	4,784,507
6 2	1,469,972	35.53	2,667,299	64.47	0		4,137,271	8,921,778
6 3	1,551,474	47.81	1,693,609	52.19	0		3,245,083	12,166,861
6 4	625,599	71.63	246,379	28.21	1,397	.16	873,375	13,040,236
6 5	590,635	58.75	414,701	41.25	0		1,005,336	14,045,572
6 6	886,780	58.45	630,380	41.55	0		1,517,160	15,562,732
6 7	739,374	66.03	380,381	33.97	0		1,119,755	16,682,487
6 8	485,185	70.46	203,411	29.54	0		688,596	17,371,083
6 9	154,799	56.91	117,208	43.09	0		272,007	17,643,090
6 10	47,644	34.69	89,699	65.31	0		137,343	17,780,433
6 11	689,231	56.10	536,888	43.70	2,457	.20	1,228,576	19,009,009
6 12	1,288,754	56.10	1,003,895	43.70	4,594	.20	2,297,243	21,306,252
6 13	1,888,249	56.10	1,470,882	43.70	6,731	.20	3,365,862	24,672,114
6 14	1,095,934	75.30	357,743	24.58	1,746	.12	1,455,423	26,127,537
6 15	309,635	53.03	273,668	46.87	583	.10	583,886	26,711,423
6 16	490,831	53.03	433,816	46.87	925	.10	925,572	27,636,995
6 17	484,329	60.90	310,956	39.10	0		795,285	28,432,280

-Continued-

Table 12. (Page 2 of 2)

Date ^a	Age I		Age II		Age III		All Ages	
	Number	Percent	Number	Percent	Number	Percent	Daily Total	Cumulative Total
6 18	576,741	66.85	284,186	32.94	1,725	.20	862,652	29,294,932
6 19	1,039,728	70.13	442,844	29.87	0		1,482,572	30,777,504
6 20	2,339,167	70.13	996,305	29.87	0		3,335,472	34,112,976
6 21	2,761,096	70.13	1,176,015	29.87	0		3,937,111	38,050,087
6 22	879,373	72.47	334,057	27.53	0		1,213,430	39,263,517
6 23	262,558	72.47	99,741	27.53	0		362,299	39,625,816
6 24	762,167	66.16	389,838	33.84	0		1,152,005	40,777,821
6 25	207,592	66.16	106,180	33.84	0		313,772	41,091,593
6 26	46,061	66.16	23,559	33.84	0		69,620	41,161,213
6 27	111,243	66.16	56,899	33.84	0		168,142	41,329,355
Total	22,143,831	53.58	19,147,877	46.33	37,647	0.09	41,329,355	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 13. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolts Naknek River, Bristol Bay, Alaska, 1986.

Date ^a	Mean Weight of Smolt (g)	Smolt per Count
5 23	15.4	2.7
5 24	15.4	2.7
5 25	15.4	2.7
5 26	15.4	2.7
5 27	15.4	2.7
5 28	15.4	2.7
5 29	15.4	2.7
5 30	15.4	2.7
5 31	14.0	3.0
6 1	14.0	3.0
6 2	12.9	3.2
6 3	12.0	3.5
6 4	10.3	4.0
6 5	11.4	3.6
6 6	11.5	3.6
6 7	10.6	3.9
6 8	10.2	4.1
6 9	11.2	3.7
6 10	13.2	3.2
6 11	11.3	3.7
6 12	no sample	3.7
6 13	11.3	3.7
6 14	9.4	4.4
6 15	11.6	3.6
6 16	11.6	3.6
6 17	10.9	3.8
6 18	10.8	3.8
6 19	10.2	4.1
6 20	10.2	4.1
6 21	no sample	4.1
6 22	10.0	4.2
6 23	10.0	4.2
6 24	10.5	4.0
6 25	no sample	4.0
6 26	no sample	4.0
6 27	no sample	4.0

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 14. Sockeye salmon spawning escapement, total number of smolt produced by age class (percent of total smolt production comprised by each age class indicated within parentheses), and number of smolt produced per spawner for 1978-1984 brood years, Naknek River, Bristol Bay, Alaska.

Brood Year	Total Spawning Escapement	Number of Smolt Produced				
		Age I	Age II	Age III	Total	Per Spawner
1978	813,378	-	-	-	-	-
1979	925,362	-	12,898,936	23,256	-	-
1980	2,644,698	115,624,396 (88)	16,497,326 (12)	594,898	132,716,620	50.18
1981	1,796,220	36,798,239 (43)	48,825,473 (57)	20,579	85,644,291	47.68
1982	1,155,552	32,139,569 (71)	13,370,305 (29)	37,647	45,547,521	39.42
1983	888,294	6,306,803	19,147,877			
1984	1,242,474	22,143,831				

Table 15. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1977-1984 brood years, Naknek River, Bristol Bay, Alaska.

Brood Year	Total ^a Spawning Escapement	Age I			Age II			Age III		
		Number of Smolt	Adult ^a Returns	Adult Returns per Smolt	Number of Smolt	Adult ^a Returns	Adult Returns per Smolt	Number of Smolt	Adult ^a Returns	Adult Returns per Smolt
1977	1,085,856	-	2,976,617		-	495,092		0	4,905	
1978	813,378	-	2,034,044		-	1,639,386		0	1,449	
1979	925,362	-	3,394,642		12,898,936	1,197,608	0.09	23,256	6,300	0.27
1980	2,644,698	115,624,396	2,193,821	0.02	16,497,326	2,048,890	0.12	594,898	0	0.00 ^b
1981	1,796,220	36,798,239	3,371,113	0.09 ^b	48,825,473	1,997,593	0.04 ^b	20,579	0	0.00 ^b
1982	1,155,552	32,139,569	977,378	0.03 ^b	13,370,305	217,169	0.02 ^b	37,647		
1983	888,294	6,306,803			19,147,877					
1984	1,242,474	22,143,831								

^a Includes interception estimates, Yuen and Nelson (1987)

^b Future adult returns will increase these values.

Table 16. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Naknek River, Bristol Bay, Alaska, 1986.

Date ^a	Age I					Age II					Age III				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
5 23					0	109		14.2		1					0
5 24	90	5.9	7.6	1.49	2	120	12.7	15.8	3.98	22					0
5 25	105		12.0		1	121	18.7	16.4	6.09	28	141		27.4		1
5 26	110		12.7	.77	2	125	11.7	18.2	5.62	23					0
5 27					0	123	12.5	17.4	4.45	18					0
5 28					0	120	14.2	16.5	5.17	30					0
5 29					0	117	20.5	15.7	7.50	60					0
5 30	109	3.5	11.5	.98	3	119	17.4	14.1	5.97	54					0
5 30	116		14.0		1	120	20.4	15.8	8.13	57	123		12.1		1
5 31	106	3.8	11.1	.76	3	114	17.9	14.2	6.07	56	143		23.0		1
6 1	103		9.2		1	114	13.9	13.9	5.32	29					0
6 2	103	15.5	11.2	5.66	79	115	20.8	14.3	7.96	130					0
6 3	101	16.1	10.2	4.08	38	113	20.3	13.6	6.02	22					0
6 4	96	24.8	9.2	7.64	139	110	17.1	13.3	5.71	38	128		19.1		1
6 5	99	17.1	10.3	6.02	78	111	16.7	13.4	5.92	42					0
6 6	97	17.8	9.6	5.18	85	113	19.3	14.0	7.97	33					0
6 7	93	21.4	8.4	5.62	73	116	19.7	15.2	8.02	17					0
6 8	93	17.2	9.2	4.98	77	119	10.1	16.3	6.82	13					0
6 9	95	21.3	9.2	6.37	63	114	18.9	14.6	8.07	26					0
6 10	96	19.9	9.3	6.39	52	119	23.0	15.6	11.10	68					0
6 11	100	16.6	9.6	5.32	22	121	20.0	16.6	9.85	62	125		19.4		1
6 14	92	21.7	8.4	6.23	201	111	23.0	13.0	7.20	38	148		31.2		1
6 16	91	15.5	8.8	4.30	58	120	21.3	16.4	6.84	50	135		20.4		1
6 17	97	18.3	9.5	6.79	80	114	23.7	14.0	8.39	69					0
6 18	96	14.1	8.6	4.01	114	113	27.9	13.8	10.47	42	130	7.7	21.9	2.20	2
6 19	95	17.7	8.1	4.12	31	113	25.2	12.7	7.32	17					0
6 20	96	12.1	9.1	3.69	47	113	16.6	14.1	4.78	12					0
Totals					1,250					1,079					9
Means	99		9.9			116		14.9			134		21.8		

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 17. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Naknek River, Bristol Bay, Alaska, 1986.

Date ^a	Estimated Age I				Estimated Age II			
	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size
5 28 ^b	104	3.0	10.8	2	119	15.3	15.6	68
5 29	106	4.8	11.2	8	118	12.7	15.1	41
5 30	106	5.2	11.4	42	118	23.1	15.3	277
5 31	103	4.7	11.0	22	117	25.7	15.1	267
6 1	101	10.5	10.5	61	115	24.3	14.3	282
6 2 ^c	101	17.4	10.4	210	113	23.2	13.6	325
6 3	99	18.6	10.0	202	113	20.2	13.7	151
6 4	94	26.7	8.7	292	112	13.9	13.5	47
6 5	98	23.8	9.7	316	112	19.2	13.6	117
6 6	97	22.1	9.5	375	115	24.6	14.3	175
6 7	94	22.7	8.7	313	116	20.9	14.7	92
6 8	93	25.9	8.4	370	114	17.9	14.1	61
6 9	92	24.5	8.2	280	117	22.2	15.1	103
6 10	98	18.0	9.6	137	117	26.9	15.2	198
6 13 ^d	92	24.0	8.2	387	117	22.9	14.8	112
6 14	89	25.7	7.7	395	115	19.1	14.4	43
6 15	92	16.4	8.1	201	121	24.6	16.1	116
6 16	95	19.0	8.8	142	114	18.9	13.9	103
6 17	96	15.2	9.0	299	113	20.0	13.5	105
6 18	95	20.3	8.8	613	117	25.5	14.8	177
6 20	95	13.7	8.9	192	113	17.1	13.5	36
6 21	94	16.1	8.5	255	111	10.2	13.1	31
6 22	91	17.6	8.1	233	116	10.3	14.5	13
6 23	93	14.5	8.5	218	117	22.2	15.0	35
6 24	94	15.7	8.6	242	112	12.2	13.3	23
Totals				5,807				2,998
Means	96		9.3		115		14.4	

-Continued-

Table 17. (Page 2 of 2)

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- ^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.
- ^b Length-weight parameters by age group and discriminating length used to separate ages for 25 May through 1 June were;
 age I $a = -9.08$ $b = 2.46$ $r^2 = .92$ $n = 13$
 age II $a = -8.96$ $b = 2.45$ $r^2 = .76$ $n = 377$
 discriminating length = 109.3
- ^c Length-weight parameters by age group and discriminating length used to separate ages for 2 June through 10 June were;
 age I $a = -9.89$ $b = 2.65$ $r^2 = .78$ $n = 683$
 age II $a = -9.77$ $b = 2.62$ $r^2 = .66$ $n = 388$
 discriminating length = 106.9
- ^d Length-weight parameters by age group and discriminating length used to separate ages for 13 June through 24 June were;
 age I $a = -7.89$ $b = 2.21$ $r^2 = .58$ $n = 552$
 age II $a = -9.49$ $b = 2.55$ $r^2 = .77$ $n = 289$
 discriminating length = 105.7

Table 18. Mean fork length and weight of sockeye salmon smolt sampled from the Naknek River, Bristol Bay, Alaska, 1957-1986.

Year of Migration	Sample Dates	Sample Size	Age I		Age II		Age III		References
			Mean Length	Mean Weight	Mean Length	Mean Weight	Mean Length	Mean Weight	
1957	-	-	111	13.1	112	13.1	-	-	USF&WS (unpublished)
1958	-	-	91	6.9	114	11.3	-	-	"
1959	-	-	97	8.2	106	10.1	-	-	"
1960	-	-	99	8.8	109	11.9	-	-	"
1961	-	-	103	10.8	113	13.8	-	-	"
1962	-	-	105	10.4	112	12.5	-	-	"
1963	-	-	98	8.1	114	12.8	-	-	"
1964	-	-	97	7.7	110	11.0	-	-	"
1965	-	-	99	8.4	114	13.0	-	-	"
1966	31 May-13 July	933	106	10.6	118	14.2	-	-	Robertson (1967)
1967	27 May- 9 July	855	113	13.1	119	14.7	-	-	Van Valin (1969a)
1968	23 May-12 August	1,380	99	8.4	108	11.1	-	-	Van Valin (1969b)
1969	30 May-27 June	1,079	100	7.5	112	12.1	-	-	Siedelman (1972)
1970	29 May- 5 July	932	100	9.0	114	12.1	-	-	Biwer (1972)
1971	6 June-7 July	-	102	8.8	120	13.5	-	-	McCurdy (1972a)
1972	8 June-6 July	689	98	9.1	110	11.9	-	-	McCurdy (1974a)
1973	28 May-26 June	745	106	10.7	114	12.9	122	15.2	McCurdy (1974b)
1974	22 May-27 June	827	104	10.3	118	14.5	109	11.3	Bill (1975)
1975	28 May- 9 July	1,037	98	8.3	111	12.1	109	11.5	Bill (1976)
1976	22 May-26 June	833	91	7.2	107	13.4	131	22.2	Bill (1977)
1977	20 May-23 June	1,178	92	7.2	113	11.9	-	-	Yuen (1978)
1978	1 June	239	96	8.3	105	11.0	-	-	Huttenun (1980)
1982	24 May-10 July	3,222	94	8.0	100	14.7	-	-	Huttenun (1984)
1983	17 May- 5 July	2,480	94	8.0	110	12.2	133	19.1	Fried et al. (1987)
1984	22 May- 5 July	3,011	97	8.8	108	11.4	124	16.7	Fried et al. (1986)
1985	23 May- 1 July	6,528	96	8.7	109	11.7	119	15.6	Bue (1986)
Mean			100	8.3	112	12.6	121	16.0	
1986	23 May-27 June	2,329	99	9.9	116	14.9	134	21.8	

Table 19. Climatological and hydrological observations made at sockeye salmon smolt counting site, Naknek River, Bristol Bay, Alaska, 1986.

Date	Cloud Cover ^a		Wind Velocity (km/h)		Air Temp. (°C)	Water Temp. (°C)	Precipitation (mm)	Water Clarity
	0800 hr	2000 hr	0800 hr	2000 hr				
5 23	-	1	-	-	- - -	- - 9.5	0.0	-
5 24	1	2	- SW	- W	0.0-20.0	9.0- 9.0	0.0	turbid
5 25	5	3	- SW	- SW	1.1-20.0	12.0-11.5	0.0	clear
5 26	3	1	4 N	8 N	0.5-17.8	11.0-12.0	0.0	turbid
5 27	1	2	3 N	3 NW	-2.2-17.8	11.0-12.0	0.0	turbid
5 28	5	1	7 SW	3 S	1.1-19.0	10.0-13.0	0.0	turbid
5 29	1	3	5 NE	15 S	1.1-18.0	12.0-13.0	0.0	turbid
5 30	4	4	3.5 SE	8 W	7.2-16.6	12.0-12.0	0.0	turbid
5 31	3	3	0 SE	9-10 SE	5.6-13.3	11.0-13.0	1.5	turbid
6 1	4	4	0	8 S	4.4-12.2	11.0-13.0	10.4	turbid
6 2	4	4	3.5 SE	10 NE	14.4-14.4	10.0-10.0	0.5	turbid
6 3	3	4	8 SE	8 SE	10.0-11.1	9.0- 9.0	0.3	turbid
6 4	3	4	0 NE	9 SE	5.6-15.6	9.0- 9.5	0.3	turbid
6 5	1	2	0 SE	5-10 SE	0.0-16.7	9.0- 9.5	0.0	turbid
6 6	4	3	7 SE	7 NE	8.9-13.9	9.0- 9.5	0.0	turbid
6 7	4	3	9.5 NE	3 S	10.0-12.2	9.0- 9.0	0.0	turbid
6 8	4	3	9.5 NE	3 S	11.0-11.0	11.0- 9.5	0.0	turbid
6 9	3	3	calm	calm	0.0-16.7	9.5- 9.5	0.2	turbid
6 10	5	3	0 NE	5 SE	1.1-16.7	11.0-11.0	0.0	turbid
6 11	2	-	calm	40 NE	- - -	11.0- -	0.0	turbid
6 12	4	-	40 NE	40 NE	- - -	8.5- -	0.0	turbid
6 13	4	4	- NE	calm	5.6-11.1	9.0- 9.0	0.2	turbid

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Table 19. (Page 2 of 2)

Date	Cloud Cover ^a		Wind Velocity (km/h)		Air Temp. (°C)	Water Temp. (°C)	Precipitation (mm)	Water Clarity
	0800 hr	2000 hr	0800 hr	2000 hr				
6 14	4	2	calm	calm	7.2- 8.9	11.0-10.0	0.1	turbid
6 15	2	1	calm	5 S	3.3-21.0	10.0-12.0	0.0	clear
6 16	2	3	4 S	3-5 SW	- -18.5	10.0-12.0	0.0	turbid
6 17	4	4	6 S	5 SW	4.4-21.0	10.0- 9.5	0.0	turbid
6 18	4	4	- S	calm	6.1-11.6	9.0- 9.5	0.0	turbid
6 19	4	3	calm	5-10 NE	- - -	10.0- -	0.0	turbid
6 20	3	4	6-7 NE	10-20 NE	6.7-14.4	10.0-10.0	tr.	turbid
6 21	4	4	calm	0-5 NE	7.7-14.4	10.5-10.0	tr.	turbid
6 22	4	4	calm	15 W	6.1-16.6	11.0-11.0	0.02	turbid
6 23	4	4	3-5 SE	15 NE	6.4- 9.0	10.0-10.0	0.0	turbid
6 24	4	4	3-5 SE	5 SE	8.5-10.0	10.0-10.5	0.0	turbid
6 25	4	4	3-5 SE	10-15 SE	4.4- 9.0	9.5-10.5	0.0	turbid
6 26	4	4	calm	3-5 SE	7.8- 9.0	10.0-11.0	0.0	turbid
6 27	4	4	calm	3-5 NE	6.1- 9.0	10.0-11.5	tr.	turbid
6 28	4	-	calm	- -	10.5- -	10.5- -	0.0	-

- ^a
- 1 = cloud cover not more than 1/10
 - 2 = cloud cover not more than 1/2
 - 3 = cloud cover more than 1/2
 - 4 = completely overcast
 - 5 = fog

Table 20. Water temperatures at sockeye salmon smolt counting site, Naknek River, Bristol Bay, Alaska, 1967-1986.

Year	Sample Period	Water Temperature (°C)			Reference
		Minimum	Maximum	Mean	
1967	27 May-11 July	10.6	15.0	13.0	Van Valin (1969a)
1968	21 May-14 July	7.2	16.7	12.9	Van Valin (1969b)
1969	27 May-16 July	6.7	13.9	11.0	Siedelman (1972)
1970	27 May-16 June	11.1	14.4	12.1	Biwer (1972)
1971	7 June- 7 July	4.4	10.0	7.2	McCurdy (1972a)
1972	8 June- 6 July	6.7	14.4	10.1	McCurdy (1974a)
1973	29 May-26 June	6.9	15.9	11.1	McCurdy (1974b)
1974	21 May-27 June	8.1	14.3	12.1	Bill (1975)
1975	28 May- 9 July	3.5	13.2	9.0	Bill (1976)
1976	22 May-26 June	4.6	12.8	9.5	Bill (1977)
1982	21 May-10 July	5.0	14.4	8.9	Huttenun (1984)
1983	20 May- 6 July	8.0	16.0	12.8	Fried et al. (1987)
1984	19 May- 6 July	7.5	16.0	13.0	Fried et al. (1986)
1985	21 May- 3 July	6.5	16.0	10.5	Bue (1986)
	Mean	6.9	14.5	10.9	
1986	23 May-28 June	8.5	13.0	10.4	

Table 21. Sonar counts recorded from three 10 transducer arrays at the sockeye salmon smolt counting site on the Egegik River, Bristol Bay, Alaska, 1986.

Sonar Counts				
Transducer Array				
Date ^a	Inshore	Center	Offshore	Total
5 18	0	0	0	0
5 19	0	0	0	0
5 20	0	0	0	0
5 21	0	0	0	0
5 22	55	45	125	225
5 23	9	335	265	609
5 24	3,355	3,172	408	6,935
5 25	12,174	12,715	16,298	41,187
5 26	147,053	156,173	44,746	347,972
5 27	396,887	235,629	145,313	777,829
5 28	246,902	48,318	34,426	329,646
5 29	460,264	207,342	148,408	816,014
5 30	9,320	29,271	28,994	67,585
5 31	151,680	189,439	51,051	392,170
6 1	382,573	31,399	53,878	467,850
6 2	3,398	538	301	4,237
6 3	133,684	36,895	37,136	207,715
6 4	32,359	9,023	3,130	44,512
6 5	27,751	3,498	4,631	35,880
6 6	502	14,617	29,646	44,765
6 7	153	861	605	1,619
6 8	949	850	35	1,834
6 9	1,930	2,926	4,196	9,052
6 10	129	633	495	1,257
6 11	2,952	2,352	1,417	6,721
Total	2,014,079	986,031	605,504	3,605,614
Percent	55.86	27.35	16.79	

^a Sample day began at 1200 hours and ended at 1159 hrs the next calendar day.

Table 22. Daily number of sockeye salmon smolt migrating seaward in the Egegik River, Bristol Bay, Alaska, 1986, as estimated with a sonar unit.

Date ^a	Age I		Age II		Age III		All Ages	
	Number	Percent	Number	Percent	Number	Percent	Daily Total	Cumulative Total
5 18	0		0		0		0	0
5 19	0		0		0		0	0
5 20	0		0		0		0	0
5 21	0		0		0		0	0
5 22	18	.94	1993	98.93	2	.13	2013	2013
5 23	47	.94	5039	98.93	6	.13	5092	7105
5 24	600	.94	63225	98.93	83	.13	63908	71013
5 25	3425	.94	360547	98.93	473	.13	364445	435458
5 26	442115	12.25	3166988	87.75	0		3609103	4044561
5 27	871388	10.88	7137694	89.12	0		8009082	12053643
5 28	388809	10.88	3184809	89.12	0		3573618	15627261
5 29	2850564	28.28	7229225	71.72	0		10079789	25707050
5 30	28184	4.52	595375	95.48	0		623559	26330609
5 31	491442	11.95	3621049	88.05	0		4112491	30443100
6 1	5355375	66.87	2653261	33.13	0		8008636	38451736
6 2	48203	66.87	23881	33.13	0		72084	38523820
6 3	2292073	66.87	1135582	33.13	0		3427655	41951475
6 4	437577	61.18	277652	38.82	0		715229	42666704
6 5	324637	57.68	238187	42.32	0		562824	43229528
6 6	418019	64.66	228469	35.34	0		646488	43876016
6 7	15277	64.66	8349	35.34	0		23626	43899642
6 8	19801	64.66	10822	35.34	0		30623	43930265
6 9	89791	64.66	49075	35.34	0		138866	44069131
6 10	11912	64.66	6510	35.34	0		18422	44087553
6 11	71328	64.66	38984	35.34	0		110312	44197865
Total	14,160,585	32.04	30,036,716	67.96	564	0.00	44,197,865	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 23. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolts, Egegik River, Bristol Bay, Alaska, 1986.

Date ^a	Mean Weight of Smolt (g)	Smolt per Count
5 18	no sample	2.3
5 19	no sample	2.3
5 20	no sample	2.3
5 21	no sample	2.3
5 22	18.2	2.3
5 23	no sample	2.3
5 24	18.2	2.3
5 25	18.2	2.3
5 26	15.7	2.6
5 27	16.2	2.6
5 28	16.2	2.6
5 29	13.7	3.0
5 30	16.8	2.5
5 31	15.6	2.7
6 1	10.6	3.9
6 2	no sample	3.9
6 3	10.6	3.9
6 4	11.0	3.8
6 5	11.5	3.6
6 6	10.6	3.9
6 7	10.6	3.9
6 8	10.6	3.9
6 9	no sample	3.9
6 10	no sample	3.9
6 11	no sample	3.9

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 24. Sockeye salmon spawning escapement, total number of smolt produced by age class (percent of total smolt production comprised by each age class indicated within parentheses), and number of smolt produced per spawner for 1978-1984 brood years, Egegik River, Bristol Bay, Alaska.

Brood Year	Total Spawning Escapement	Number of Smolt Produced				
		Age I	Age II	Age III	Total	Per Spawner
1978	895,698	-	-	225,522	-	-
1979	1,032,042	-	14,287,075	0	-	-
1980	1,060,860	49,457,563 (74)	16,524,563 (25)	197,429	66,179,555	62.38
1981	694,680	2,242,326 (7)	32,235,734 (93)	52,852	34,530,912	49.71
1982	1,034,628	17,234,269 (60)	11,434,848 (40)	564	28,669,681	27.71
1983	792,282	54,585,828	29,984,140			
1984	1,165,320	14,016,441				

Table 25. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1978-1984 brood years, Egegik River, Bristol Bay, Alaska.

Brood Year	Total ^a Spawning Escapement	Age I			Age II			Age III		
		Number of Smolt	Adult ^a Returns	Adult ^a Returns per Smolt	Number of Smolt	Adult ^a Returns	Adult ^a Returns per Smolt	Number of Smolt	Adult ^a Returns	Adult ^a Returns per Smolt
1978	895,698	-	907,413		-	8,310,922		225,522	33,756	0.15
1979	1,032,042	-	1,246,161		14,287,075	4,737,895	0.33	0	0	0.00
1980	1,060,860	49,457,563	3,027,613	0.06	16,524,563	5,502,662	0.33	197,429	7,732	0.04
1981	694,680	2,242,326	1,533,092	0.68	32,235,734	4,868,868	0.15 ^b	52,852	8,726	0.17 ^b
1982	1,034,628	17,234,269	2,895,570	0.17	11,434,848	1,814,189	0.16 ^b	564	0	0.00 ^b
1983	792,282	54,585,828	1,759,245	0.03 ^b	29,984,140	7,304	0.00 ^b			
1984	1,165,320	14,016,441								

^a Includes interception estimates, Yuen and Nelson (1987)

^b Future adult returns will increase these values.

Table 26. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Egegik River, Bristol Bay, Alaska, 1986.

Date ^a	Age I					Age II					Age III				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
5 22					0	130	14.1	18.3	5.18	8					
5 24					0	132	15.8	19.8	7.10	32					
5 25					0	126	21.0	18.2	8.78	89	140		22.6		1
5 26	103	10.6	10.0	3.39	25	120	24.6	15.7	10.10	74					
5 27	106	6.2	11.1	1.98	4	127	21.0	17.8	9.24	96					
5 28	101	10.2	9.5	2.40	23	124	21.5	16.1	9.50	76					
5 29	100	9.1	8.6	3.32	29	120	22.4	14.7	8.17	67					
5 30	104	2.2	10.0	0.86	3	127	20.5	17.1	8.59	97					
5 31	102	9.6	8.7	2.29	19	125	23.4	16.3	8.72	79					
6 3	96	12.3	8.3	3.35	83	120	18.0	15.3	6.99	17					
6 4	99	11.9	8.6	3.24	81	112	16.3	12.5	5.40	19					
6 5	100	16.5	7.6	2.97	80	117	22.2	11.2	7.13	15					
6 6	98	9.5	8.1	2.60	39	117	14.0	13.8	4.69	14					
6 8	98	8.9	8.1	2.28	41	115	16.9	12.3	5.31	9					
Totals					427					692					1
Means	101		9.0			122		15.7			140		22.6		

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 27. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Egegik River, Bristol Bay, Alaska, 1986.

Date ^a	Estimated Age I				Estimated Age II			
	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size
5 25 ^b	101	6.4	9.1	6	127	27.7	17.6	304
5 26	103	8.7	9.5	44	123	30.1	16.1	313
5 27	103	7.4	9.5	5	126	26.1	17.3	184
5 28	101	11.3	9.2	70	123	29.6	16.3	274
5 29	100	13.0	8.9	145	119	26.6	14.6	252
5 30	102	6.9	9.3	20	124	29.7	16.7	302
5 31	102	8.5	8.8	53	124	31.0	16.0	317
6 1	98	12.2	8.1	115	116	14.8	12.7	50
6 3 ^c	98	14.4	8.0	188	117	17.4	13.1	36
6 4	97	15.6	8.0	275	116	22.1	12.8	99
6 5	99	17.3	8.2	262	122	32.7	14.7	124
6 6	97	15.7	8.0	166	117	18.0	13.1	60
6 7	99	8.7	8.2	43	117	14.7	13.0	15
6 8	97	13.1	7.9	151	114	16.7	12.4	29
Totals				1543				2349
Means	100		8.6		120		14.7	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

^b Length-weight parameters by age group and discriminating length used to separate ages for 25 May through 1 June were;
age I $a = -10.77$ $b = 2.81$ $r^2 = .67$ $n = 103$
age II $a = -10.08$ $b = 2.65$ $r^2 = .87$ $n = 610$
discriminating length = 108.2

^c Length-weight parameters by age group and discriminating length used to separate ages for 2 June through 8 June were;
age I $a = -5.91$ $b = 1.74$ $r^2 = .34$ $n = 282$
age II $a = -11.22$ $b = 2.91$ $r^2 = .69$ $n = 73$
discriminating length = 107.1

Table 28. Mean fork length and weight of sockeye salmon smolt sampled from the Egegik River, Bristol Bay, Alaska, 1939-1986.

Year of Migration	Sample Dates	Sample Size	Age I		Age II		Age III		References
			Mean Length	Mean Weight	Mean Length	Mean Weight	Mean Length	Mean Weight	
1939	-	-	96	-	105	-	-	-	USF&WS (unpublished)
1956	-	386	101	-	116	-	123	-	"
1957	-	236	107	-	120	-	130	-	"
1959	-	281	99	-	116	-	123	-	"
1960	-	159	106	-	115	-	140	-	"
1969	-	67	99	-	119	-	115	-	Paulus (1972)
1977	27-29 May	299	110	11.3	116	13.3	-	-	ADF&G (unpublished)
1978	19-22 May	319	104	10.1	122	15.4	130	18.1	Huttunen (1980)
1981	15 May- 6 June	549	105	9.1	122	16.6	128	19.1	Bue (1982)
1982	27 May-15 June	881	104	9.2	130	17.1	145	23.5	Bue (1984)
1983 ^a	17 May- 9 June	2,631	101	9.3	116	13.6	-	-	Fried and Yuen (in press)
1984 ^a	10 May-10 June	3,602	106	10.1	112	12.2	134	20.2	Fried et al. (1986)
1985 ^a	24 May- 5 June	5,427	106	10.4	123	16.8	138	24.1	Bue (1986)
Mean			103	9.9	117	14.7	130	20.2	
1986	18 May-11 June	1,120	101	9.0	122	15.7	140	22.6	

^a Age, weight, and length samples pooled with estimated weight by age from length samples.

Table 29. Mean fork length and weight of coho salmon smolt captured in fyke nets, Egegik River, Bristol Bay, Alaska, 1986.

Date ^a	Age II					Age III				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
6 3	140		25.5		1	151		32.7		1
6 6	140	11.9	28.1	7.00	4	164		50.2		1
Totals					5					2
Means	140		26.8			158		41.5		

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 30. Climatological and hydrological observations made at sockeye salmon smolt counting site, Egegik River, Bristol Bay, Alaska, 1986.

Date	Cloud Cover ^a		Wind Velocity (km/h)		Air Temp. (°C)		Mean Water Temp. (°C)	Precipitation (cm)	Water Clarity
	0800 hr	2000 hr	0800 hr	2000 hr	0800	2000			
5 19	4	4	5-10 W	10 W	0	-	3.0	0	clear
5 20	4	1	5 SW	10-15 NW	3	5	2.7	0	clear
5 21	1	1	5-10 NW	5-10 E	2	6	2.2	0	clear
5 22	4	3	10 E	10-15 E	4	6	2.7	0	clear
5 23	1	1	3 SE	5 E	5	10	5.7	0	clear
5 24	1	3	calm	5-10 NW	5	12	4.2	0	clear
5 25	3	4	5 SE	5-10 E	11	11	4.2	0	clear
5 26	3	1	5 E	5 W	10	10	4.5	0	clear
5 27	1	1	5 NW	5-10 W	11	10	5.7	0	clear
5 28	4	1	5 SW	5-10 E	5	11	5.2	0	clear
5 29	3	3	5-10 E	10-15 E	5	6	4.7	0	clear
5 30	4	4	5 E	calm	6	9	7.5	.05	clear
5 31	4	3	5-10 E	10-20 E	5	7	5.0	.01	clear
6 1	4	4	10-15 E	-	4	5	3.5	.36	clear
6 2	4	4	15-20 E	30-35 E	5	6	3.7	.06	clear
6 3	3	4	40 E	>40 E	9	11	5.0	trace	light brown
6 4	4	3	10-15 E	10-15 E	5	7	4.5	.01	clear
6 5	2	1	5 E	10-15 E	6	5	4.7	0	clear
6 6	3	4	calm	3 N	6	8	4.0	.02	clear
6 7	4	3	calm	5 N	8	11	5.2	.02	clear
6 8	4	4	5 N	10-15 E	7	8	5.0	.01	clear
6 9	4	3	5 SE	5 WSW	6	11	5.7	.23	clear
6 10	3	2	5 E	15-20 E	6	8	4.5	0	clear
6 11	4	4	5-10 E	5-10 E	6	6	4.0	.30	clear
6 12	3	-	5 E	-	6	-	4.5	0	clear

- ^a
- 1 = cloud cover not more than 1/10
 - 2 = cloud cover not more than 1/2
 - 3 = cloud cover more than 1/2
 - 4 = completely overcast
 - 5 = fog

Table 31. Water temperatures at sockeye salmon smolt counting site, Egegik River, Bristol Bay, Alaska, 1981-1986.

Year	Sample Period	Water Temperature (°C)			Reference
		Minimum	Maximum	Mean	
1981	15 May-8 June	5.0	9.0	7.3	Bue (1982)
1982	15 May-16 June	0.0	5.0	2.9	Bue (1984)
1983	18 May-10 June	5.0	9.5	7.0	Fried et al. (1987)
1984	17 May-11 June	5.0	10.0	7.6	Fried et al. (1986)
1985	17 May-12 June	2.5	7.5	4.2	Bue (1986)
	Mean	3.5	8.2	5.8	
1986	23 May-28 June	2.2	7.5	7.2	

Table 32. Sonar counts recorded from two 10 transducer arrays at the sockeye salmon smolt counting site on the Ugashik River, Bristol Bay, Alaska, 1986.

Sonar Counts			
Date ^a	Transducer Array		Total
	Inshore	Center	
5 21	3,749	680	4,429
5 21	3,749	680	4,429
5 22	362	599	961
5 23	14,018	13,940	27,958
5 24	4,841	1,583	6,424
5 25	74,060	92,694	166,754
5 26	11,804	3,440	15,244
5 27	7,308	1,554	8,862
5 28	61,961	93,099	155,060
5 29	1,971	93,226	95,197
5 30	708,543	234,541	943,084
5 31	353,634	197,638	551,272
6 1	242,958	361,860	604,818
6 2	173,767	325,456	499,223
6 3	104,784	289,162	393,946
6 4	35,800	252,867	288,667
6 5	5,636	257,397	263,033
6 6	710	14,037	14,747
6 7	2,405	183,400	185,805
6 8	55,799	205,773	261,572
6 9	2,583	30,349	32,932
6 10	49,204	199,206	248,410
6 11	107	4,806	4,913
6 12	1,267	1,609	2,876
6 13	15,601	37,303	52,904
Total	1,932,872	2,896,219	4,829,091
Percent	40.03	59.97	

^a Sample day began at 1200 hours and ended at 1159 hrs the next calendar day.

Table 33. Daily number of sockeye salmon smolt migrating seaward in the Ugashik River, Bristol Bay, Alaska, 1986, as estimated with a sonar unit.

Date ^a	Age I		Age II		All Ages	
	Number	Percent	Number	Percent	Daily Total	Cumulative Total
5 21	38,643	79.88	9,733	20.12	48,376	48,376
5 22	9,871	79.88	2,486	20.12	12,357	60,733
5 23	275,705	79.88	69,444	20.12	345,149	405,882
5 24	58,014	79.88	14,612	20.12	72,626	478,508
5 25	1,675,877	79.88	422,116	20.12	2,097,993	2,576,501
5 26	105,992	71.38	42,498	28.62	148,490	2,724,991
5 27	60,479	71.38	24,249	28.62	84,728	2,809,719
5 28	1,226,602	71.38	491,809	28.62	1,718,411	4,528,130
5 29	1,028,644	79.70	262,001	20.30	1,290,645	5,818,775
5 30	6,171,221	67.50	2,971,328	32.50	9,142,549	14,961,324
5 31	3,409,500	64.73	1,857,764	35.27	5,267,264	20,228,588
6 1	3,802,974	63.74	2,163,411	36.26	5,966,385	26,194,973
6 2	3,185,304	63.74	1,812,035	36.26	4,997,339	31,192,312
6 3	2,569,494	63.74	1,461,717	36.26	4,031,211	35,223,523
6 4	1,926,819	63.74	1,096,116	36.26	3,022,935	38,246,458
6 5	2,457,260	75.87	781,517	24.13	3,238,777	41,485,235
6 6	136,773	75.87	43,499	24.13	180,272	41,665,507
6 7	1,739,769	75.87	553,323	24.13	2,293,092	43,958,599
6 8	2,394,628	78.30	663,645	21.70	3,058,273	47,016,872
6 9	578,695	93.59	39,634	6.41	618,329	47,635,201
6 10	4,250,687	93.91	275,654	6.09	4,526,341	52,161,542
6 11	71,917	86.06	11,649	13.94	83,566	52,245,108
6 12	34,310	86.06	5,557	13.94	39,867	52,284,975
6 13	680,974	86.06	110,304	13.94	791,278	53,076,253
Total	37,890,152	71.39	15,186,101	28.61	53,076,253	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 34. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolt, Ugashik River, Bristol Bay, Alaska, 1986.

Date ^a	Mean Weight of Smolt (g)	Smolt per Count
5 21	6.5	6.4
5 22	6.5	6.4
5 23	6.5	6.4
5 24	6.5	6.4
5 25	6.5	6.4
5 26	7.5	5.5
5 27	no sample	5.5
5 28	7.5	5.5
5 29	6.9	6.0
5 30	7.6	5.5
5 31	7.9	5.3
6 1	8.1	5.1
6 2	no sample	5.1
6 3	no sample	5.1
6 4	8.1	5.1
6 5	7.1	5.8
6 6	7.1	5.8
6 7	7.1	5.8
6 8	7.1	5.8
6 9	5.9	7.0
6 10	5.8	7.2
6 11	no sample	6.2
6 12	no sample	6.2
6 13	6.7	6.2

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 35. Sockeye salmon spawning escapement, total number of smolt produced by age class (percent of total smolt production comprised by each age class indicated within parentheses), and number of smolt produced per spawner for 1979-1984 brood years, Ugashik River, Bristol Bay, Alaska.

Brood Year	Total Spawning Escapement	Number of Smolt Produced				Per Spawner
		Age I	Age II	Age III	Total	
1979	1,700,904	-	-	0	-	
1980	3,321,384	-	12,736,379	26,384	-	
1981	1,326,762	31,297,432 (27)	82,656,993 (73)	0	113,954,425	85.89
1982	1,157,526	75,491,249 (78)	21,407,762 (22)	0	96,899,011	83.71
1983	1,000,614	12,693,628	15,186,101			
1984	1,241,418	37,890,152				

Table 36. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1979-1984 brood years, Ugashik River, Bristol Bay, Alaska.

Brood Year	Total ^a Spawning Escapement	Age I		Age II			Age III		
		Number of Smolt	Adult ^a Returns	Adult ^a Returns per Smolt	Number of Smolt	Adult ^a Returns	Adult ^a Returns per Smolt	Number of Smolt	Adult ^a Returns per Smolt
1979	1,700,904	-	3,963,182		-	2,004,153		0	0
1980	3,321,384	-	3,463,594		12,736,379	4,193,490	0.33	26,384	2,548
1981	1,326,762	31,297,432	4,171,255	0.13	82,656,993	3,179,851	0.04	0	1,187
1982	1,157,526	75,491,249	1,140,372	0.02	21,407,762	605,875	0.03 ^b	0	0.00 ^b
1983	1,000,614	12,693,628	610,066	0.05 ^b	15,186,101	5,046	0.00 ^b		
1984	1,241,418	37,890,152	57	0.00 ^b					

^a Includes interception estimates, Yuen and Nelson (1987)

^b Future adult returns will increase these values.

Table 37. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Ugashik River, Bristol Bay, Alaska, 1986.

Date ^a	Age I					Age II				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (gm)	Std. Error	Sample Size
5 21	82	22.9	4.7	3.70	36	108	5.4	10.2	1.52	8
5 22	83	16.5	5.2	3.58	26	118	4.7	12.8	2.08	4
5 23	87	23.3	5.5	5.05	101	112	10.8	12.0	3.48	36
5 24	88	15.5	5.8	3.15	69	115	15.1	12.3	5.53	31
5 25	90	18.0	6.4	3.75	57	112	11.9	11.3	3.63	43
5 26	89	14.5	6.3	3.51	40	111	7.3	11.2	2.30	8
5 28	90	12.3	6.6	2.59	38	110	16.7	11.3	4.93	58
5 29	89	16.6	6.3	3.62	76	108	10.1	10.7	2.81	23
5 30	90	16.8	6.2	4.25	28	115	17.3	12.4	6.04	72
5 31	87	10.7	5.9	3.13	39	115	14.4	12.6	4.89	60
6 1	85	11.7	5.5	2.33	53	107	6.8	10.4	2.01	11
6 4	89	13.6	6.2	3.51	87	109	15.4	10.9	4.06	13
6 5	86	13.8	5.6	3.11	64	115	12.5	12.8	4.09	36
6 7	83	10.9	5.2	2.34	85	122	9.0	15.6	3.33	15
6 8	85	14.0	5.6	3.18	63	116	12.4	13.5	4.23	37
6 9	84	12.6	5.7	3.01	95	123	3.8	14.8	2.05	5
6 10	85	14.3	5.3	2.80	93	116	10.6	13.4	4.11	7
6 14	85	12.7	6.0	3.03	86	119	11.5	14.8	4.72	14
Totals					1074					481
Means	87		5.8			114		10.9		

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 38. Mean fork length and estimated weight, by estimated age of sockeye salmon smolt length frequencies, Ugashik River, Bristol Bay, Alaska, 1986.

Date ^a	Estimated Age I				Estimated Age II			
	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size	Mean Length (mm)	Std. Error	Estimated Mean Weight (g)	Sample Size
5 23 ^b	86	11.5	5.6	14	110	4.5	11.1	4
5 24	85	8.9	5.5	9	110	8.4	11.3	5
5 25	87	20.5	5.8	269	111	20.2	11.6	74
5 28	87	19.2	5.8	200	112	20.2	11.9	96
5 29	88	18.5	5.9	284	110	14.5	11.2	93
5 30	85	22.2	5.6	354	112	18.6	11.7	138
5 31	86	19.4	5.6	197	113	18.9	12.0	116
6 1	86	14.9	5.6	89	112	15.1	11.8	57
6 4	88	16.6	6.0	131	116	22.1	13.0	169
6 5	85	10.2	5.4	47	115	14.7	12.7	32
6 6	86	12.8	5.7	101	115	19.8	12.7	86
6 7	83	20.1	5.1	287	116	12.0	12.9	27
6 8	85	17.0	5.4	246	117	18.6	13.5	67
6 9	85	17.7	5.5	341	113	11.1	12.0	21
6 10	85	19.7	5.4	360	111	11.2	11.4	20
6 13	85	16.5	5.4	258	119	26.3	14.2	65
Totals				3,187				1,070
Means	86		5.6		113		12.2	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

^b Length-weight parameters by age group and discriminating length used to separate ages for 23 May through 13 June were;
age I a= -11.34 b= 2.93 r²= .81 n= 1101
age II a= -10.85 b= 2.82 r²= .86 n= 473
discriminating length = 100.86

Table 39. Mean fork length and weight of sockeye salmon smolt sampled from the Ugashik River, Bristol Bay, Alaska, 1958-1986.

Year of Migration	Sample Dates	Sample Size	Age I		Age II		Age III		References
			Mean Length	Mean Weight	Mean Length	Mean Weight	Mean Length	Mean Weight	
1958	-	-	93	6.4	112	11.7	-	-	Pella and Jaenicke (1978)
1959	-	-	90	6.1	120	13.5	-	-	"
1960	-	-	90	6.6	104	11.0	-	-	"
1961	-	-	90	6.7	112	12.2	-	-	"
1962	12 May-28 June	1,070	88	6.1	112	12.3	-	-	Jaenicke (1963)
1963	5 May-26 June	921	90	6.1	104	9.6	-	-	Nelson and Jaenicke (1965)
1964	15 May-20 June	4,042	92	6.9	118	12.7	-	-	Nelson (1965)
1965	13 May-20 June	3,296	94	6.9	114	12.5	-	-	Nelson (1966)
1967	15 May-12 June	966	88	6.0	113	12.2	-	-	Nelson (1969)
1968	13 May-24 June	6,727	93	6.5	113	10.7	-	-	Siedelman (1969)
1969	23 May- 6 June	567	97	7.5	121	14.5	-	-	Schroeder (1972a)
1970	15 May-10 June	907	97	7.7	125	15.9	-	-	Schroeder (1972b)
1972	28 May-20 June	615	81	5.0	112	11.2	129	14.3	Schroeder (1974a)
1973	17 May-12 June	1,189	93	7.2	113	11.9	132	20.1	Schroeder (1974b)
1974	17 May-17 June	355	94	7.4	119	13.6	-	-	Schroeder (1975)
1975	3-13 June	-	96	7.2	116	13.0	125	16.7	Sanders (1976)
1982	6- 8 June	512	88	6.3	113	13.0	138	22.5	Eggers (1984)
1983	21 May-16 June	9,502	89	7.6	111	13.2	-	-	Fried et al. (1987)
1984	23 May-16 June	4,810	87	6.8	102	10.3	103	11.7	Fried et al. (1986)
1985	22 May-17 June	3,473	94	8.3	107	11.8	-	-	Bue (1986)
			—	—	—	—	—	—	
		Mean	91	6.8	113	12.3	125	17.1	
1986	21 May-14 June	1,555	87	5.8	114	10.9	-	-	

Table 40. Climatological and hydrological observations made at sockeye salmon smolt counting site, Ugashik River, Bristol Bay, Alaska, 1986.

Date	Cloud Cover ^a		Wind Velocity (km/h)		Air Temp. (°C)	Water Temp. (°C)	Water Clarity
	0800 hr	2000 hr	0800 hr	2000 hr			
5 20	4	3	25 W	15 W			clear
5 21	1	1	5 SW		11.0- 2.0	2.0	clear
5 22	2	3	25 E	30 N	6.0- 3.0	4.0-5.0	clear
5 23	2	1	10 NE	10 N	13.0- 6.0	4.0-4.5	clear
5 24	1	1	calm	10 SW	16.0- 1.0	5.0-6.0	clear
5 25	3	2	5 S	10 E	9.0- 0.0	5.0-5.0	clear
5 26	3	1	2 W	10 W	2.0- 5.0	5.0-5.0	clear
5 27	1	1	10 SW	20 S	13.0- 4.0	4.5-6.5	clear
5 28	4	1	5 S	calm	11.0- 2.0	3.5-5.0	clear
5 29	3	3	15 NE	20 E	10.0- 3.0	6.0-7.0	clear
5 30	4	4	5 E	calm	14.0- 4.0	5.0-5.0	clear
5 31	4	4	5 NE		9.0- 4.0	5.5-7.0	clear
6 1	4	3	2 W	5 S	9.0- 4.0	7.0-6.0	clear
6 2	4		30 E	35 NE	10.0- 3.0	6.0-5.0	turbid
6 3	4	4	45 E	35 E	6.0- 3.0	6.0-5.0	turbid
6 4	3	3	5 E	5 E	10.0- 4.0	5.0-7.0	L. Brown
6 5	1	3	1 E	15 E	13.0- 4.0	6.0-8.0	clear
6 6	3	4	20 N	2 N	10.0- 6.0	7.0-6.0	L. Brown
6 7	4	4	2 N	calm	11.0- 5.0	5.0-5.0	clear
6 8	3	4	1 SW	10 W	10.0- 5.0	5.5-6.0	clear
6 9	4	3	calm		10.0- 4.0	5.5-5.5	clear
6 10	4		5 NE	20 NE	15.0- 5.0	7.0-5.0	clear
6 11	4		15 E			7.0- -	clear
6 12	4	4	30 NE	15 NE	9.0- 5.0	6.0-6.5	L. Brown
6 13	3		10 NE	15 NE	10.0- 5.0	6.0-7.0	clear
6 14	4	3	calm	5 SW	13.0- 5.0	6.0-7.0	clear

- ^a
- 1 = cloud cover not more than 1/10
 - 2 = cloud cover not more than 1/2
 - 3 = cloud cover more than 1/2
 - 4 = completely overcast
 - 5 = fog

Table 41. Water temperatures at sockeye salmon smolt counting site, Ugashik River, Bristol Bay, Alaska, 1983-1986.

Year	Sample Period	Water Temperature (°C)			Reference
		Minimum	Maximum	Mean	
1983	23 May-11 June	6.0	8.5	7.3	Fried et al. (1987)
1984	20 May-17 June	4.8	8.5	6.3	Fried et al. (1986)
1985	17 May- 9 June	-1.0	7.0	4.3	Bue (1986)
	Mean	3.3	8.0	6.0	
1986	23 May-28 June	2.0	7.0	5.6	

Table 42. Sonar counts recorded from four 10 transducer arrays at the sockeye salmon smolt counting site on the Wood River, Bristol Bay, Alaska, 1986.

Sonar Counts					
Date ^a	Transducer Array				Total
	I	II	III	IV	
5 27	1,087	238	454	348	2,127
5 28	503	584	1,109	969	3,165
5 29	354	1,166	971	1,010	3,501
5 30	2,475	1,921	1,436	842	6,674
5 31	6,569	1,828	1,646	940	10,983
6 1	2,446	2,442	1,968	1,810	8,666
6 2	2,250	4,768	1,550	1,266	9,834
6 3	830	1,136	1,038	1,228	4,232
6 4	1,595	1,244	2,646	2,237	7,722
6 5	1,419	2,248	2,208	1,151	7,026
6 6	1,694	2,636	1,880	708	6,918
6 7	1,084	1,623	1,926	1,487	6,120
6 8	1,235	1,640	1,694	1,702	6,271
6 9	2,431	3,890	2,520	4,036	12,877
6 10	2,413	5,086	2,884	3,968	14,351
6 11	5,638	14,098	6,146	4,238	30,120
6 12	2,882	9,902	5,160	10,032	27,976
6 13	1,907	3,206	1,518	1,390	8,021
6 14	3,828	4,028	2,018	1,982	11,856
6 15	11,788	12,680	2,206	1,698	28,372
6 16	12,137	15,872	5,042	2,994	36,045
6 17	7,799	13,364	6,618	4,377	32,158
6 18	10,659	27,416	13,997	8,944	61,016
6 19	3,363	7,816	5,762	8,034	24,975
6 20	3,181	4,036	2,266	2,306	11,789
6 21	2,970	8,682	5,177	3,166	19,995
6 22	8,188	18,902	17,732	8,509	53,331
6 23	9,762	6,634	4,500	2,100	22,996
6 24	1,846	3,798	1,309	1,012	7,965
6 25	4,103	6,335	3,011	1,900	15,349
6 26	16,787	9,690	4,012	3,886	34,375
6 27	8,057	14,078	9,910	3,614	35,659
6 28	1,868	4,102	2,670	2,649	11,289

-Continued-

Table 42. (Page 2 of 2)

Sonar Counts					
Transducer Array					
Date ^a	I	II	III	IV	Total
6 29	13,294	16,443	11,246	3,791	44,774
6 30	11,859	18,454	12,784	7,018	50,115
7 1	11,940	16,046	9,211	8,278	45,475
7 2	11,886	11,322	6,333	8,154	37,695
7 3	9,165	10,742	4,908	2,238	27,053
7 4	5,821	8,294	2,810	3,146	20,071
7 5	2,579	3,472	3,320	3,010	12,381
7 6	2,625	5,226	3,594	2,352	13,797
7 7	2,519	4,145	2,399	3,858	12,921
7 8	1,976	5,290	2,946	2,494	12,706
7 9	4,993	3,652	2,694	2,734	14,073
7 10	4,255	4,166	2,294	2,388	13,103
7 11	5,937	4,572	3,582	3,064	17,155
7 12	4,862	6,574	4,224	3,866	19,526
7 13	6,345	7,046	2,990	2,698	19,079
7 14	4,642	4,532	2,726	2,912	14,812
7 15	299	668	936	1,148	3,051
Total	250,145	347,733	203,981	159,682	961,541
Percent	26.02	36.16	21.21	16.61	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 43. Percentage of total unexpanded sonar counts recorded over each array, Wood River, Bristol Bay, Alaska, 1975-1986.

Percentage of Sonar Counts					
Transducer Array					References
Year	I	II	III	IV	
1975 ^a	68.6	31.4	-	-	Krasnowski (1976)
1976	49.0	30.2	11.7	9.1	Krasnowski (1977)
1977	36.0	24.4	20.8	18.8	Newcome (1978)
1978	28.6	29.7	25.6	16.1	Clark and Robertson (1980)
1979	17.0	27.1	33.1	22.8	Bucher (1980)
1980	34.1	35.2	20.5	10.2	Bucher (1981)
1981	39.2	24.8	24.9	11.1	Bucher (1982)
1982	38.2	31.3	15.9	14.6	Bucher (1984)
1983	31.6	29.9	23.5	15.0	Bucher (1987)
1984	23.9	36.7	22.2	17.2	Bucher (1986)
1985	34.2	36.3	18.5	11.0	Bucher (1986)
Mean ^b	33.2	30.6	21.7	14.6	
1986	34.2	36.3	18.5	11.0	

^a Only two transducer arrays used.

^b Data for 1975 omitted.

Table 44. Velocity correction factors used at
Wood River, Bristol Bay, Alaska, 1986.

Date	Array II	Array III	Array IV
6 1	1.00	.93	.88
6 6	1.07	1.15	1.19
6 11	1.00	1.07	1.11
6 18	1.12	1.16	1.22
6 24	1.09	1.11	1.13
6 30	1.00	1.00	1.00
7 03	1.00	1.09	1.07
7 08	1.00	1.02	1.09

Table 45. Daily number of sockeye salmon smolt migrating seaward in the Wood River, Bristol Bay, Alaska, 1986, as estimated with a sonar unit.

Date ^a	Age I			Age II			All Ages	
	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
5 27	61,030	98.68	61,030	814	1.32	814	61,845	61,845
5 28	93,884	98.68	154,914	1,253	1.32	2,067	95,137	156,982
5 29	100,340	98.68	255,255	1,339	1.32	3,406	101,680	258,662
5 30	176,807	98.68	432,062	2,359	1.32	5,766	179,166	437,829
5 31	298,205	98.68	730,268	3,980	1.32	9,747	302,186	740,015
6 1	240,826	98.68	971,095	3,214	1.32	12,961	244,040	984,056
6 2	247,205	98.68	1,218,300	3,299	1.32	16,260	250,505	1,234,561
6 3	122,012	98.68	1,340,312	1,628	1.32	17,889	123,640	1,358,202
6 4	222,314	98.68	1,562,627	2,967	1.32	20,856	225,281	1,583,484
6 5	178,972	98.68	1,741,600	2,388	1.32	23,245	181,361	1,764,845
6 6	176,202	95.07	1,917,803	9,127	4.93	32,373	185,330	1,950,176
6 7	184,962	95.07	2,102,765	9,581	4.93	41,954	194,543	2,144,719
6 8	193,451	95.07	2,296,217	10,021	4.93	51,975	203,472	2,348,192
6 9	411,281	95.07	2,707,498	21,304	4.93	73,280	432,585	2,780,778
6 10	488,942	97.51	3,196,440	12,485	2.49	85,765	501,427	3,282,206
6 11	813,764	97.51	4,010,205	20,780	2.49	106,545	834,544	4,116,751
6 12	956,536	97.51	4,966,741	24,425	2.49	130,971	980,962	5,097,713
6 13	226,449	97.51	5,193,190	5,782	2.49	136,754	232,232	5,329,945
6 14	317,112	97.47	5,510,303	8,247	2.54	145,002	325,360	5,655,305
6 15	655,530	97.47	6,165,834	17,049	2.54	162,052	672,580	6,327,886
6 16	858,273	97.47	7,024,107	22,323	2.54	184,375	880,596	7,208,482
6 17	812,314	97.47	7,836,422	21,127	2.54	205,503	833,442	8,041,925
6 18	1,829,523	98.76	9,665,945	23,064	1.25	228,567	1,852,588	9,894,513
6 19	916,205	98.76	10,582,151	11,550	1.25	240,118	927,756	10,822,269
6 20	383,508	98.76	10,965,659	4,834	1.25	244,953	388,343	11,210,612
6 21	608,133	98.76	11,573,792	7,666	1.25	252,620	615,799	11,826,412
6 22	1,656,802	98.51	13,230,595	25,145	1.50	277,765	1,681,948	13,508,360

-Continued-

Table 45. (Page 2 of 2)

Date ^a	Age I			Age II			All Ages	
	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
6 23	680,393	98.51	13,910,989	10,326	1.50	288,091	690,719	14,199,080
6 24	226,504	98.51	14,137,493	3,437	1.50	291,529	229,941	14,429,022
6 25	436,982	98.51	14,574,476	6,632	1.50	298,161	443,614	14,872,637
6 26	911,072	97.25	15,485,548	25,738	2.75	323,899	936,811	15,809,448
6 27	893,384	97.25	16,378,933	25,239	2.75	349,139	918,623	16,728,072
6 28	324,885	97.25	16,703,818	9,178	2.75	358,317	334,063	17,062,135
6 29	1,119,669	97.25	17,823,488	31,632	2.75	389,949	1,151,302	18,213,437
6 30	1,266,677	97.29	19,090,165	35,283	2.71	425,232	1,301,960	19,515,398
7 1	1,214,894	97.29	20,305,060	33,840	2.71	459,073	1,248,735	20,764,134
7 2	1,057,973	97.29	21,363,034	29,469	2.71	488,543	1,087,443	21,851,577
7 3	691,135	97.29	22,054,170	19,251	2.71	507,794	710,387	22,561,964
7 4	569,389	99.77	22,623,559	1,312	.23	509,107	570,702	23,132,667
7 5	388,067	99.77	23,011,627	894	.23	510,001	388,962	23,521,629
7 6	394,375	99.77	23,406,003	909	.23	510,911	395,284	23,916,914
7 7	422,460	99.77	23,828,463	973	.23	511,884	423,433	24,340,348
7 8	391,300	97.69	24,219,764	9,232	2.30	521,117	400,533	24,740,881
7 9	461,152	97.69	24,680,916	10,880	2.30	531,997	472,032	25,212,914
7 10	419,701	97.69	25,100,617	9,902	2.30	541,899	429,603	25,642,517
7 11	553,379	97.69	25,653,997	13,056	2.30	554,956	566,436	26,208,954
7 12	627,348	97.69	26,281,346	14,801	2.30	569,757	642,149	26,851,104
7 13	584,293	97.69	26,865,639	13,785	2.30	583,543	598,079	27,449,183
7 14	484,241	97.69	27,349,880	11,425	2.30	594,968	495,666	27,944,849
7 15	116,803	97.69	27,466,684	2,755	2.30	597,724	119,559	28,064,408
Total	27,466,684	97.87		597,724	2.13		28,064,408	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 46. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolts, Wood River, Bristol Bay, Alaska, 1986.

Date ^a	Mean Weight of Smolt (g)	Smolt per Count
5 27	no sample	7.14
5 28	no sample	7.14
5 29	5.81	7.14
5 30	5.81	7.14
5 31	5.81	7.14
6 1	5.81	7.14
6 2	no sample	7.14
6 3	5.81	7.14
6 4	5.81	7.14
6 5	5.81	7.14
6 6	6.07	6.83
6 7	6.07	6.83
6 8	6.07	6.83
6 9	6.07	6.83
6 10	5.59	7.42
6 11	5.59	7.42
6 12	5.59	7.42
6 13	5.59	7.42
6 14	5.94	6.99
6 15	5.94	6.99
6 16	5.94	6.99
6 17	5.94	6.99
6 18	5.59	7.42
6 19	5.59	7.42
6 20	5.59	7.42
6 21	5.59	7.42
6 22	5.54	7.49
6 23	5.54	7.49
6 24	5.54	7.49
6 25	5.54	7.49
6 26	6.05	6.86
6 27	6.05	6.86
6 28	6.05	6.86
6 29	6.05	6.86
6 30	5.70	7.28
7 1	5.70	7.28
7 2	5.70	7.28
7 3	5.70	7.28
7 4	5.67	7.32

-Continued-

Table 46. (Page 2 of 2)

Date ^a	Mean Weight of Smolt (g)	Smolt per Count
7 5	5.67	7.32
7 6	5.67	7.32
7 7	5.67	7.32
7 8	5.20	7.98
7 9	5.20	7.98
7 10	5.20	7.98
7 11	5.20	7.98
7 12	5.20	7.98
7 13	5.20	7.98
7 14	5.20	7.98
7 15	no sample	7.98

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 47. Sockeye salmon spawning escapements, total number of smolt produced by age class (percent of total smolt production comprised by each age class indicated within parentheses), and number of smolt produced per spawner for 1972-1984 brood years, Wood River, Bristol Bay, Alaska.

Brood Year	Total Spawning Escapement	Number of Smolt Produced			
		Age I	Age II	Total	Per Spawner
1972	430,602	-	5,900,000	-	-
1973	330,474	27,950,000 (85)	4,800,000 (15)	32,750,000	99.24
1974	1,708,836	101,400,000 (89)	12,550,000 (11)	113,950,000	66.64
1975	1,270,116	60,750,000 (88)	8,400,000 (12)	69,150,000	54.45
1976	817,008	46,600,000 (90)	5,127,868 (10)	51,727,868	63.31
1977	561,828	60,838,182 (97)	1,993,345 (3)	62,831,527	111.83
1978	2,267,238	46,302,587 (58)	33,196,940 (42)	79,499,527	35.06
1979	1,706,352	64,330,507 (92)	4,706,853 (8)	69,037,360	40.46
1980	2,969,040	32,354,984 (89)	4,133,901 (11)	36,488,885	12.29
1981	1,233,318	19,594,247 (93)	1,378,417 (7)	20,972,664	17.01
1982	976,470	22,332,474 (83)	4,692,859 (17)	27,025,333	27.68
1983	1,360,968	31,948,110 (98)	597,724 (2)	32,545,834	23.91
1984	1,002,792	27,466,684	-	-	-

Table 48. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt, for 1972-1984 brood years, Wood River, Bristol Bay, Alaska.

Brood Year	Total Spawning Escapement	Age I			Age II		
		Number of Smolt	Adult Returns	Adult Returns per Smolt	Number of Smolt	Adult Returns	Adult Returns per Smolt
1972	430,602	-	1,430,065		5,900,000	59,353	0.01
1973	330,474	27,950,000	1,364,992	0.05	4,800,000	118,476	0.02
1974	1,708,836	101,400,000	4,661,537	0.05	12,550,000	496,546	0.04
1975	1,270,116	60,750,000	3,617,378	0.06	8,400,000	1,141,143	0.14
1976	817,008	46,600,000	4,895,420	0.11	5,127,868	867,507	0.17
1977	561,828	60,838,182	3,399,952	0.06	1,993,345	116,606	0.06
1978	2,267,238	46,302,587	2,546,030	0.05	33,196,940	742,252	0.02
1979	1,706,352	64,330,507	4,497,413	0.07	4,706,853	46,750	0.01
1980	2,969,040	32,354,984	1,585,416	0.05	4,133,901	187,961	0.05
1981	1,233,318	19,594,247	1,815,951	0.09	1,378,417	84,629	0.06 ^a
1982	976,470	22,332,474	505,649	0.02 ^a	4,692,859	466	0.00 ^a
1983	1,360,968	31,948,110	1,225	0.00 ^a	597,724	-	
1984	1,002,792	27,466,684	-		-	-	

^a Future adult returns will increase these values.

Table 49. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Wood River, Bristol Bay, Alaska, 1986.

Date	Age I					Age II				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
5 29	87	.6	5.1	.13	34	104		9.6		1
5 30	85	1.1	4.7	.26	8					0
5 31	87	.7	5.8	.16	34	82		4.4		1
6 1	84	4.0	4.7	.70	2					0
6 3	87	.3	6.1	.06	232	109	3.5	11.9	.92	7
6 4	90	3.0	5.8	1.20	2					0
6 5	87	.3	8.2	2.32	173	85		5.1		1
6 6	87	.4	6.0	.46	121	102	5.6	9.4	1.59	4
6 7	88	.5	5.8	.10	110	110	2.8	11.6	.85	10
6 8	86	.3	5.8	.08	115	110	4.0	11.8	1.12	5
6 9	87	.4	5.7	.08	120	105	5.7	10.7	1.68	5
6 10	87	.3	5.6	.07	119	112	3.0	11.1	.20	2
6 11	85	.3	5.2	.07	117					0
6 12	88	.4	5.8	.10	111	95	3.7	7.5	.94	9
6 13	86	.3	5.6	.08	122	85		4.6		1
6 14	87	.4	6.0	.08	113	95	3.5	7.6	.75	2
6 15	87	.4	5.8	.09	110	97	2.4	8.3	.59	9
6 16	87	.3	6.1	.07	118	90		7.1		1
6 17	85	.3	5.7	.08	118					0
6 18	85	.3	5.8	.08	119	101		9.0		1
6 19	83	.3	5.4	.07	121					0
6 20	84	.3	5.2	.07	119	84	1.0	5.5	.20	2
6 21	86	.5	5.9	.10	117	105	12.3	9.4	2.42	3
6 22	87	.5	5.8	.11	115	95	6.0	7.3	1.35	2
6 23	84	.4	5.2	.09	112	100	.0	8.9	.55	2
6 24	86	.5	5.8	.11	116	102	4.5	9.6	.35	2
6 25	83	.3	5.2	.08	119	92		6.7		1

Table 49. (Page 2 of 2)

Date	Age I					Age II				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
6 26	87	.5	5.9	.10	117	100	10.5	9.1	2.65	2
6 27	87	.5	6.0	.10	118	107		12.0		1
6 28	87	.4	5.8	.10	114	106	2.3	10.4	.72	4
6 29	88	.5	6.1	.11	112	105	4.0	10.4	1.12	6
6 30	86	.4	5.5	.09	116	106	3.4	10.0	.75	4
7 1	91	.6	6.6	.14	112	106	2.7	10.3	.87	8
7 2	84	.4	5.3	.09	120					0
7 3	83	.4	5.0	.08	118	102		9.1		1
7 4	83	.4	5.4	.08	119					0
7 5	86	.4	5.7	.09	120					0
7 6	85	.5	5.8	.11	120					0
7 7	85	.5	5.6	.10	108	100		9.4		1
7 8	89	.5	6.7	.12	114	111	9.2	13.7	3.31	4
7 9	89	.5	6.7	.12	119	107		9.6		1
7 10	89	.5	7.0	.12	118	101	6.0	8.1	2.80	2
7 11	92	.5	7.4	.12	116	107	1.9	8.8	2.48	4
7 12	92	.8	7.6	.20	66	102		8.7		1
7 13	91	1.0	7.2	.28	27	102	7.5	9.5	1.60	2
7 14	90	.5	7.0	.13	117	116	3.8	13.5	1.28	3
Totals					4,888					115
Means	87		5.9			101		9.2		

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 50. Age composition of total migration, and mean fork length (mm) and weight (g) by age class, for sockeye salmon smolt, Wood River, Bristol Bay, Alaska, 1951-1986.

Year of Migration	Age I			Age II			Total Estimate	References
	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)		
1951 ^a	80.0	91	-	20.0	-	-	-	Univ. Washington (unpub.)
1952	99.0	87	-	1.0	-	-	-	"
1953	95.3	86	-	4.7	103	-	-	"
1954	95.8	87	-	4.2	107	-	-	"
1955	98.0	85	-	2.0	102	-	-	"
1956	78.4	82	-	21.6	95	-	-	"
1957	80.7	77	-	19.3	93	-	-	"
1958	65.0	82	-	35.0	102	-	-	"
1959	93.5	88	-	6.5	105	-	-	"
1960	99.4	88	-	0.6	114	-	-	"
1961	93.0	82	-	7.0	102	-	-	Church (1963)
1962	86.0	80	-	14.0	98	-	-	Church and Nelson (1963)
1963	84.3	83	-	15.7	102	-	-	Nelson (1964)
1964	98.8	84	-	1.2	104	-	-	Nelson (1965)
1965	92.0	86	-	8.0	106	-	-	Nelson (1966)
1966	94.3	77	-	5.7	101	-	-	Siedelman (1967)
1975 ^b	86.0	83	-	14.0	98	-	33,850,000	Krasnowski (1976)
1976	95.5	84	-	4.5	95	-	106,200,000	Krasnowski (1977)
1977	82.9	71	3.5	17.1	98	9.3	73,300,000	Newcome (1978)
1978	84.7	79	-	15.3	90	-	55,000,000	Clark and Robertson (1980)
1979	92.2	90	7.6	7.8	100	10.1	65,966,050	Bucher (1980)
1980	96.0	78	4.0	4.0	95	6.8	48,295,932	Bucher (1981)
1981	66.1	88	6.3	33.9	96	8.4	97,527,446	Bucher (1982)
1982	87.3	79	4.7	12.7	98	8.4	37,061,837	Bucher (1984)

-Continued-

Table 50. (Page 2 of 2)

Year of Migration	Age I			Age II			Total Estimate	References
	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)	Percent of Total Estimate	Mean Length (mm)	Mean Weight (g)		
1983	82.6	86	6.5	17.4	98	9.2	23,728,252	Bucher (1987)
1984	94.2	92	7.8	5.8	97	8.7	23,710,947	Bucher (1986)
1985	87.2	92	7.2	12.8	91	7.1	36,640,969	Bucher (1986)
	Mean	80	5.4		96	8.7	54,661,948	
1986	97.9	92	7.2	2.1	91	7.1		

^a Fyke net catches used to index abundance of smolt, 1951-1966.

^b Sonar equipment used to estimate numbers of smolt, 1975-1985.

Table 51. Estimated infection by the cestode *Trienophorus crassus* of Age I and Age II sockeye salmon smolt by 5 day periods, Wood River, Bristol Bay, Alaska, 1986.

Sample period	Age I		Age II	
	Number Examined	Percent Infected	Number Examined	Percent Infected
5 29-6 3	310	27.7	9	44.4
6 4-6 8	521	35.5	20	40.0
6 9-6 13	589	33.8	17	64.7
6 14-6 18	578	42.4	13	46.2
6 19-6 23	584	39.4	9	66.7
6 24-6 28	584	43.7	10	20.0
6 29-7 3	578	40.8	19	47.4
7 4-7 8	581	39.9	5	20.0
7 9-7 13	446	32.5	10	70.0
7 14-7 14	117	26.5	3	.0
5 29-7 14	4888	40.8	115	45.6

Table 52. Infection of sockeye salmon smolt by the cestode
Triaenophorus crassus, Wood River, Bristol
 Bay, Alaska, 1978-1986.

Year	Percent Infected		References
	Age I	Age II	
1978	15.1	40.5	Clark and Robertson (1980)
1979	10.0	30.8	Bucher (1980)
1980	11.1	17.3	Bucher (1981)
1981	28.2	35.6	Bucher (1982)
1982	10.0	21.2	Bucher (1984)
1983	43.1	73.6	Bucher (1987)
1984	41.1	45.7	Bucher (1986)
1985	35.7	41.5	Bucher (1986)
Mean	24.3	38.3	
1986	40.8	45.6	

Table 53. Water temperatures and depths,
at field camp site, head of
Wood River (outlet of Lake
Aleknagik), Bristol Bay,
Alaska, 1986.

	Mean Water Temp. (°C)	Mean Water Depth (m)
5 24	6.5	- 0.61
5 25	5.5	- 0.30
5 26	5.5	- 0.30
5 27	5.5	- 0.30
5 28	6.0	- 0.30
5 29	5.5	- 0.30
5 30	5.0	- 0.30
5 31	4.5	- 0.30
6 1	4.5	- 0.25
6 2	5.0	- 0.25
6 3	4.0	0.30
6 4	-	-
6 5	6.0	0.51
6 6	5.0	0.54
6 7	-	-
6 8	4.8	0.65
6 9	4.8	0.67
6 10	-	0.68
6 11	5.1	0.72
6 12	5.0	0.79
6 13	4.9	0.84
6 14	5.0	0.88
6 15	5.3	0.91
6 16	5.4	0.94
6 17	5.8	0.97
6 18	5.0	0.98
6 19	4.9	0.98
6 20	4.9	0.98
6 21	4.9	0.99
6 22	4.9	1.00
6 23	5.4	1.02
6 24	5.1	1.05
6 25	4.9	1.06
6 26	4.9	1.06
6 27	5.4	-
6 28	5.0	1.01
6 29	5.5	0.98
6 30	6.0	0.93

-Continued-

Table 53. (Page 2 of 2)

Date	Mean Water Temp. (°C)	Mean Water Depth (m)
7 1	7.1	0.90
7 2	7.8	0.85
7 3	8.9	0.82
7 4	7.3	0.80
7 5	6.5	0.78
7 6	6.3	0.74
7 7	7.5	0.72
7 8	8.3	0.69
7 9	8.0	0.66
7 10	8.8	0.64
7 11	9.8	0.62
7 12	10.3	0.59
7 13	10.3	0.56
7 14	9.9	0.51
7 15	8.0	0.46
Mean	6.1	0.57

Table 54. Water temperatures and depths at field camp site, head of Wood River (outlet of Lake Aleknagik), Bristol Bay, Alaska, 1975-1986.

Year	Sample Period	Water Temperature (°C)			Water Depth (m)			References
		Minimum	Maximum	Mean	Minimum	Maximum	Mean	
1975	29 May-19 July	2.0	9.5	5.0	-0.24	0.57	0.37	Krasnowski (1976)
1976	9 June- 7 August	2.0	14.0	8.0	0.24	1.07	0.57	Krasnowski (1977)
1977	9 June- 8 August	4.5	15.5	9.0	-	-	1.52	Newcome (1978)
1978	28 May- 9 August	5.0	16.0	9.0	0.37	0.98	0.82	Clark and Robertson (1980)
1979	30 May- 2 August	4.5	16.0	9.0	0.33	1.46	0.93	Bucher (1980)
1980	30 May-15 August	4.5	18.0	9.0	0.34	1.65	1.07	Bucher (1981)
1981	27 May-13 August	5.4	17.5	11.4	0.03	1.21	0.55	Bucher (1982)
1982	27 May-10 August	2.2	12.0	6.4	0.46	1.62	1.17	Bucher (1984)
1983	28 May-26 July	4.4	12.8	8.7	0.46	1.19	0.90	Bucher (1987)
1984	22 May-27 July	4.4	16.7	10.8	-0.21	0.23	0.01	Bucher (1986)
1985	6 June- 8 August	2.2	10.6	6.3	0.43	1.40	0.99	Bucher (1986)
	Mean	3.8	14.6	8.4	0.25	1.22	0.88	
1986	23 May-17 July	3.0	10.5	6.1	-0.61	1.06	0.57	

Table 55. Sonar counts recorded from three 10 transducer arrays at the sockeye salmon smolt counting site on the Nuyakuk River, Bristol Bay, Alaska, 1986.

Date ^a	Transducer Array			Total
	Inshore	Center	Offshore	
5 25	239	112	125	476
5 26	186	177	44	407
5 27	196	225	89	510
5 28	165	269	184	618
5 29	208	121	40	369
5 30	213	35	128	376
5 31	73	100	29	202
6 1	205	219	250	674
6 2	337	309	220	866
6 3	473	217	332	1,022
6 4	264	460	492	1,216
6 5	2,232	1,075	307	3,614
6 6	3,117	4,772	2,255	10,144
6 7	16,078	23,651	17,823	57,552
6 8	3,726	9,305	9,619	22,650
6 9	807	605	613	2,025
6 10	1,923	936	1,333	4,192
6 11	1,591	1,141	1,111	3,843
6 12	955	1,295	1,149	3,399
6 13	906	1,202	1,362	3,470
6 14	4,061	2,462	1,854	8,377
6 15	2,223	2,502	2,050	6,775
6 16	1,959	2,557	1,979	6,495
6 17	1,591	2,472	2,312	6,375
6 18	869	1,130	1,613	3,612
6 19	1,735	1,400	1,409	4,544
6 20	593	697	1,021	2,311
6 21	585	892	1,379	2,856
6 22	556	667	696	1,919
6 23	368	425	592	1,385
6 24	142	248	386	776
6 25	233	162	356	751
6 26	77	114	173	364
6 27	235	262	278	775
Total	49,121	62,216	53,603	164,940
Percent	29.78	37.72	32.50	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 56. Daily number of sockeye salmon smolt migrating seaward in the Nuyakuk River, Bristol Bay, Alaska, 1986, as estimated with a sonar unit.

Date ^a	Age I			Age II			All Ages	
	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
5 24	65,108	92.92	65,108	4,958	7.08	4,958	70,066	70,066
5 25	28,648	99.25	28,648	216	0.75	216	28,864	28,864
5 26	23,699	99.25	52,347	179	0.75	395	23,878	52,742
5 27	32,513	99.25	84,860	245	0.75	640	32,758	85,500
5 28	45,240	99.25	130,100	341	0.75	981	45,581	131,081
5 29	19,391	99.25	149,491	146	0.75	1,127	19,537	150,618
5 30	22,099	99.25	171,590	167	0.75	1,294	22,266	172,884
5 31	12,899	99.25	184,489	97	0.75	1,391	12,996	185,880
6 1	49,266	99.25	233,755	372	0.75	1,763	49,638	235,518
6 2	56,521	99.25	290,266	427	0.75	2,190	56,948	292,466
6 3	61,663	99.25	351,939	465	0.75	2,655	62,128	354,594
6 4	88,806	99.25	440,745	671	0.75	3,326	89,477	444,071
6 5	152,027	95.29	592,772	7514	4.70	10,840	159,541	603,612
6 6	629,725	97.86	1,222,497	13,770	2.14	24,610	643,495	1,247,107
6 7	4,293,284	99.82	5,515,781	7,741	0.18	32,351	4,301,025	5,548,132
6 8	1,617,555	100.00	7,133,336	0		32,351	1,617,555	7,165,687
6 9	118,835	100.00	7,252,171	0		32,351	118,835	7,284,522
6 10	239,676	98.75	7,491,847	3,033	1.25	35,384	242,709	7,527,231
6 11	220,591	98.75	7,712,438	2,792	1.25	38,176	223,383	7,750,614
6 12	198,118	94.98	7,910,556	10,471	5.02	48,647	208,589	7,959,203
6 13	211,881	94.98	8,122,437	11,198	5.02	59,845	223,079	8,182,282
6 14	434,079	96.05	8,556,516	17,851	3.95	77,696	451,930	8,634,212
6 15	420,482	97.61	8,976,998	10,295	2.39	87,991	430,777	9,064,989
6 16	411,343	97.61	9,388,341	10,071	2.39	98,062	421,414	9,486,403
6 17	397,491	92.72	9,785,832	31,209	7.28	129,271	428,700	9,915,103
6 18	232,878	92.72	10,018,710	18,284	7.28	147,555	251,162	10,166,265

-Continued-

Table 56. (Page 2 of 2)

Date ^a	Age I			Age II			All Ages	
	Number	Percent	Cumulative Total	Number	Percent	Cumulative Total	Daily Total	Cumulative Total
6 19	266,497	96.05	10,285,207	10,959	3.95	158,514	277,456	10,443,721
6 20	158,814	97.88	10,444,021	3,439	2.12	161,953	162,253	10,605,974
6 21	207,681	98.16	10,651,702	3,892	1.84	165,845	211,573	10,817,547
6 22	128,067	98.97	10,779,769	1,332	1.03	167,177	129,399	10,946,946
6 23	92,820	98.19	10,872,589	1,711	1.81	168,888	94,531	11,041,477
6 24	55,964	98.19	10,928,553	1,031	1.81	169,919	56,995	11,098,472
6 25	54,471	98.19	10,983,024	1,004	1.81	170,923	55,475	11,153,947
6 26	27,830	98.19	11,010,854	513	1.81	171,436	28,343	11,182,290
6 27	52,899	98.19	11,063,753	975	1.81	172,411	53,874	11,236,164
Total	11,063,753	98.47		172,411	1.53			11,236,164

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 57. Adjustment factors used to expand sonar counts into estimated numbers of sockeye salmon smolts, Nuyakuk River, Bristol Bay, Alaska, 1986.

Date ^a	Mean Weight of Smolt (g)	Smolt per Count
5 25	no sample	8.8
5 26	no sample	8.8
5 27	no sample	8.8
5 28	4.7	8.8
5 29	no sample	8.8
5 30	4.7	8.8
5 31	4.7	8.8
6 1	no sample	8.8
6 2	no sample	8.8
6 3	4.7	8.8
6 4	4.7	8.8
6 5	4.8	8.6
6 6	4.7	8.9
6 7	4.2	9.8
6 8	4.6	9.1
6 9	4.6	9.1
6 10	no sample	9.2
6 11	4.5	9.2
6 12	4.8	8.7
6 13	4.8	8.7
6 14	4.5	9.2
6 15	4.5	9.3
6 16	4.5	9.3
6 17	4.5	9.2
6 18	4.5	9.2
6 19	4.3	9.7
6 20	4.2	9.8
6 21	4.2	9.9
6 22	4.2	10.0
6 23	4.3	9.7
6 24	4.3	9.7
6 25	4.3	9.7
6 26	4.3	9.7
6 27	no sample	9.7

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 58. Sockeye salmon spawning escapements, total number of smolt produced by age class (percent of total smolt production comprised by each age class indicated within parentheses), and number of smolt produced per spawner for 1980-1984 brood years, Nuyakuk River, Bristol Bay, Alaska.

Brood Year	Total Spawning Escapement	Number of Smolt Produced			
		Age I	Age II	Total	Per Spawner
1980	3,026,568	-	1,259,339	-	-
1981	834,204	28,875,158 (99)	89,911 (1)	28,965,069	34.72
1982	537,864	6,293,644 (89)	769,319 (11)	7,062,963	13.13
1983	318,606	22,596,725	172,411	22,769,136	71.46
1984	472,596	11,063,753			

Table 59. Sockeye salmon spawning escapements, smolt production, adult returns, and smolt survival (number of adults produced per smolt) for 1979-1984 brood years, Nuyakuk River, Bristol Bay, Alaska.

Brood Year	Total ^a Spawning Escapement	Age I			Age II		
		Number of Smolt	Adult ^a Returns	Adult Returns per Smolt	Number of Smolt	Adult ^a Returns	Adult Returns per Smolt
1980	3,026,568	-	643,982		1,259,339	212,695	0.17
1981	834,204	28,875,158	2,014,591	0.07	89,911	5,608	0.06 ^b
1982	537,864	6,293,644	99,735	0.02 ^b	769,319	521	0.00 ^b
1983	318,606	22,596,725	0	0.00 ^b	172,411	-	
1984	472,596	11,063,753	-				

^a Includes interception estimates, Yuen and Nelson (1987)

^b Future adult returns will increase these values.

Table 60. Mean fork length and weight of sockeye salmon smolt captured in fyke nets, Nuyakuk River, Bristol Bay, Alaska, 1986.

Date ^a	Age I					Age II				
	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
5 28	76	22.4	4.5	3.96	10					0
5 30	81	21.4	5.0	3.51	26					0
5 31	75	12.0	3.6	1.31	6					0
6 3	72	20.3	3.5	2.58	5					0
6 4	85	12.9	5.6	2.89	100					0
6 5	85	16.9	5.9	3.98	70					0
6 6	84	12.4	5.5	3.18	80					0
6 7	82	14.1	4.7	2.19	80					0
6 8	86	13.9	5.3	2.58	78					0
6 9	81	12.5	4.4	2.16	79					0
6 11	82	23.5	4.7	3.98	157	93	2.2	6.4	.75	3
6 12	85	15.7	5.1	3.13	61	90	10.8	5.9	1.91	5
6 13	85	14.1	5.1	2.80	75	91	4.9	6.7	1.28	4
6 14	84	13.3	5.0	2.52	73	92	7.3	6.3	1.41	6
6 15	81	15.3	4.7	2.70	87	91	1.9	6.3	.39	3
6 16	80	16.2	4.5	2.90	83	91	7.0	6.2	1.37	7
6 17	83	17.6	4.8	3.20	75	93	6.4	6.5	1.56	15
6 18	81	12.4	4.4	2.10	85	90	2.9	6.2	.51	5
6 19	80	14.9	4.3	2.66	78	88	10.7	5.7	2.45	12
6 20	80	13.0	4.4	2.42	83	90	7.6	6.4	1.62	6
6 21	79	13.5	4.3	2.23	86	90	1.5	6.5	.88	4
6 22	79	15.4	4.5	2.86	87	92	1.2	6.4	.22	3
6 23	82	9.9	4.5	1.91	38	96	5.4	6.9	1.13	2
6 24	80	9.4	4.3	1.91	17					0
6 25	82	11.4	4.4	2.15	74	93	3.0	6.5	.12	2
6 26	81	14.4	4.2	2.38	69	91		5.7		1
Totals					1,762					78
Means	81		4.7			91		6.3		

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 61. Mean fork length and estimated weight, of sockeye salmon smolt captured in fyke nets, Nuyakuk River, Bristol Bay, Alaska, 1986.

Date ^a	Estimated Age I				Estimated Age II			
	Mean Length (mm)	Std. Error	Estimated Weight (g)	Sample Size	Mean Length (mm)	Std. Error	Estimated Weight (g)	Sample Size
6 4 ^b	83	18.5	4.9	279	93	3.0	6.6	21
6 5	85	12.0	5.3	84	93	3.2	6.7	16
6 6	85	17.3	5.2	188	94	2.9	6.8	12
6 7	80	16.9	4.3	199	92		6.3	1
6 13	83	16.1	5.0	171	94	4.1	6.8	16
6 14	83	13.6	4.9	101	93	2.7	6.5	9
6 16	80	13.5	4.4	118	93		6.5	1
6 18	80	15.1	4.4	190	93	1.6	6.6	10
6 19	80	17.9	4.4	190	95	3.4	6.9	11
6 20	80	13.8	4.4	98	95	.6	7.0	2
6 21	79	15.3	4.3	97	92	1.2	6.4	3
6 22	79	12.4	4.2	104	93		6.5	1
Totals				1,819				103
Means	81		4.6		93		6.6	

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

^b Length-weight parameters by age group and discriminating length used to separate ages for 4 June through 22 June were;
age I a = -11.56 b = 2.97 r² = .78 n = 1435
age II a = -11.12 b = 2.87 r² = .82 n = 70
discriminating length = 91.5

Table 62. Mean fork length and weight by age class, for sockeye salmon smolt, Nuyakuk River, Bristol Bay, Alaska, 1978, 1982-1986.

Year of Migration	Sample Dates	Sample Size	Age I		Age II		References
			Mean Length (mm)	Mean Weight (g)	Mean Length (mm)	Mean Weight (g)	
1978	18-19 June	350	71	4.3	85	5.8	Huttunen (1980)
1982	15 June- 9 July	208	76	3.9	96	6.8	Minard (1984)
1983	27 May-30 June	1,847	75	4.3	91	6.6	Minard and Frederickson (1987)
1984	27 May-26 June	980	81	4.9	93	7.3	Minard and Frederickson (1986)
1985	24 May-28 June	1,479	85	5.5	89	6.6	Minard and Brandt (1986)
			—	—	—	—	
		Mean	78	4.6	91	6.6	
1986	24 May-27 June	1,840	81	4.7	91	6.3	

Table 63. Mean fork length and weight of chinook salmon smolt captured in fyke nets, Nuyakuk River, Bristol Bay, Alaska, 1986.

Age II					
Date ^a	Mean Length (mm)	Std. Error	Mean Weight (g)	Std. Error	Sample Size
5 29	83		4.9		1
5 30	93	2.6	6.9	.56	4
5 31	108	16.1	11.9	5.35	2
6 2	95		8.6		1
6 3	95		6.9		1
6 5	96		9.1		1
6 18	82	1.2	4.7	.48	2
6 20	90	10.7	6.7	2.45	10
6 21	89	13.2	6.5	3.04	7
6 23	85	9.5	5.9	2.23	8
6 24	91	13.6	7.1	3.47	4
6 25	87	24.2	6.9	6.63	5
6 26	91		6.8		1
Totals					48
Means	91		7.1		

^a Sample day began at 1200 hrs and ended at 1159 hrs the next calendar day.

Table 64. Climatological and hydrological observations made at sockeye salmon smolt counting site, Nuyakuk River, Bristol Bay, Alaska, 1986.

Date	Cloud Cover ^a		Wind Velocity (km/hr)		Air Temp (°C)		Water Temp (°C)		Clarity	Precipitation (mm)	Water ^b Gauge (m)
	0800 hr	2000 hr	0800 hr	2000 hr	0800 hr	2000 hr	0800 hr	2000 hr			
5 25	1	1	0-5 NW	0-5 NW	-	10.0	-	7.0	clear	0.00	4.01
5 26	1	1	0-5 N	0-5 N	-	13.3	4.5	6.0	clear	0.00	4.07
5 27	1	1	5 N	0-5 N	8.8	11.1	5.0	6.0	clear	0.00	4.13
5 28	1	1	0-5 N	0-5 VAR	10.2	15.5	6.0	7.0	clear	0.00	4.14
5 29	1	3	0-5 N	0-5 VAR	8.8	11.6	6.5	5.5	clear	1.27	4.15
5 30	3		0-5 E	15-20 SE	7.8	11.7	7.0	5.5	clear	2.54	4.19
5 31	3	3	5 E	5-15 E	7.8	10.6	7.0	6.0	clear	2.54	4.22
6 1	4	4	0-5 E	0-5 VAR	6.5	8.9	6.0	5.5	clear	8.13	4.25
6 2	2	4	0-5 NE	20-25 SE	5.6	6.1	6.0	5.0	clear	1.27	4.35
6 3	4	4	5-15 E	20-30 -	6.0	6.7	6.0	5.0	clear	0.51	4.38
6 4	4	4	5-15 E	0-5 SE	5.6	7.2	6.0	5.0	-	12.19	4.51
6 5	4	3	0-5 NE	0-5 SE	5.6	8.3	5.5	5.0	-	2.03	4.70
6 6	2	3	5-10 NE	5-10 NE	6.0	11.0	5.5	5.0	clear	0.00	4.84
6 7	2	3	calm	0-5 N	6.7	12.0	5.2	5.5	clear	0.00	4.92
6 8	2	2	calm	5-10 E	14.5	11.0	5.0	7.0	clear	0.00	4.99
6 9	4	2	calm	calm	5.8	15.0	5.0	6.5	turbid	0.00	5.04
6 10	4	2	calm	5 NE	5.0	18.0	5.1	6.5	turbid	0.00	5.11
6 11	1	4	0-5 NE	10-20 E	7.0	9.0	5.5	6.0	turbid	trace	5.15
6 12	4	3	calm	5-10 E	5.0	10.0	5.0	6.0	turbid	0.64	5.19
6 13	4	2	0-5 N	0-5 E	9.5	18.0	5.6	7.0	turbid	0.00	5.28
6 14	3	2	calm	0-5 N	20.0	24.0	7.2	8.0	turbid	0.00	5.34
6 15	1	1	calm	0-5 N	20.0	24.0	7.0	9.0	turbid	0.00	5.38
6 16	1	2	calm	calm	22.0	31.0	8.2	10.0	clear	0.00	5.42
6 17	2	3	0-5 NE	calm	11.0	19.0	8.2	8.2	clear	0.00	5.47
6 18	4	4	0-5 E	0-5 E	9.0	11.0	8.0	8.5	turbid	0.00	5.54

-Continued-

Table 64. (Page 2 of 2)

Date	Cloud Cover ^a		Wind Velocity (km/hr)		Air Temp (°C)		Water Temp (°C)		Clarity	Precipitation (mm)	Water ^b Gauge (m)
	0800 hr	2000 hr	0800 hr	2000 hr	0800 hr	2000 hr	0800 hr	2000 hr			
6 19	4	2	0-5 NE	0-5 NE	7.0	7.5	7.0	16.0	turbid	trace	5.61
6 20	2	2	5-10 E	5-20 SE	12.0	12.0	8.0	6.8	turbid	0.00	5.61
6 21	4	3	10-20 S	5-10 SE	10.0	11.0	7.0	7.5	clear	trace	5.65
6 22	4	3	0-5 SE	calm	9.0	16.0	7.0	7.8	clear	7.62	5.67
6 23	4	4	5-10 S	5-10 SE	8.0	8.8	7.0	7.2	clear	trace	5.69
6 24	4	4	5-10 S	0-5 SE	11.5	10.0	7.5	7.2	clear	5.08	5.70
6 25	4	4	5-10 SE	0-5 SE	6.5	8.0	7.0	7.2	clear	7.62	5.71
6 26	4	4	calm	0-5 SE	8.0	11.0	7.5	8.0	clear	5.08	5.71
6 27	3	3	0-5 NE	5-15 SE	9.0	8.0	8.0	12.0	clear	2.54	5.68

- ^a 1 = cloud cover not more than 1/10
 2 = cloud cover not more than 1/2
 3 = cloud cover more than 1/2
 4 = completely overcast
 5 = fog

- ^b Water Gauge = depth over inshore array

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